POWER

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FRED R. LOW, *Editor*

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Controlled Monopoly Vs. Public Ownership

THERE has been so much profiteering and injustice practiced by those who have controlled the production or distribution of commodities or services that there has come to be a stigma attached to the word monopoly.

At the time of the passing of the Sherman Act, monopoly was the giant bugaboo, and competition the knight that was to hold him in bounds.

But the fact has come to be appreciated that competition is expensive; that one great organization with ample means to employ the best brains, plant and processes and free to devote its energies to production rather than to fighting for its life can serve the public better than a multiplicity of concerns with duplicate personnel and a lot of unnecessary overhead.

The cities that had competing telephone systems in the old days got a new slant on the merits of competition.

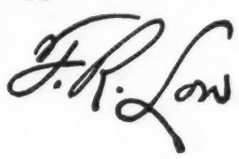
With the increase of services rendered to the public by corporations, the apportionment of territories among them and the mounting rate of amalgamation and consolidation, the monopoly question takes on new seriousness.

If an individual or a public service corporation would furnish a service at cost plus a fair profit, and if the cost were confined to actual, bona-fide necessary expenditures, the only advantages that the advocate of governmental ownership could urge would be the lower rate at which capital could be borrowed and the saving of the profit.

And this would not be too high a price to pay for enterprise, initiative, stability and freedom from political interference.

The question has been solved for the most part in America by giving to the public service corporations monopolistic rights under governmental regulation. This is a good solution so long as those appointed to safeguard the interests of the public are competent and free from any interest in, obligation to, or domination by, the party of the second part.

A realization of the modern conception of the function of big business as an institution to perform a social service at a fair remuneration rather than to take advantage of the opportunities that its bigness affords to mulct its patrons is the best solution, if it is humanly possible.



POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

Responsibility for Power-Factor Control

DELEGATING responsibility to some individual or department is recognized as a requisite to obtaining best results, but this principle has not always been applied in plant operation. The control of synchronous motors is an example.

Synchronous motors in industrial plants may be subject to a wide range of power-factor conditions for which the field current of the motors should be adjusted. The rapid increase of synchronous-motor applications in many industries has made it possible to control the power factor of the load over wide ranges. In many plants adjustment of the power factor is left to those responsible for the motor's operation instead of being under the control of the plant operator who has a direct interest in it. As a result, adjustment of power factor is not given the attention that it deserves. Load conditions vary widely. Certain combinations of induction and synchronous loads may give the desired power factor. A change in these loads may reduce the factor. Unless it is one man's job to see that the proper adjustments are made, they will generally not get attention.

Responsibility for all conditions, other than control of power factor, that may affect a power plant's operation is usually concentrated on the main switchboard. In industrial plants having a large number of synchronous motors, power-factor ministration also should be centered in the control room. In this way not only is the operator given complete responsibility for the system's power factor, but the motor controls are practically under his continuous inspection. Moreover, the control is located in a clean place, away from unfavorable conditions that might exist near the motor. This may be a considerable factor in increasing reliability and reducing maintenance costs.

The cost of such an installation for large motors will not greatly exceed that where the control is placed at the motor, and the advantage makes any increased cost a good investment. Push buttons for starting and stopping the motors can be located at advantageous points for the machine operators, but the adjustment of the motor field for power-factor correction will be under the control of those who have a direct interest in this feature of operation. Such installations have been made. The rapid expansion of synchronous-motor applications in industry calls for an extension of this practice if full advantage is to be gained from the use of these motors.

Peace and the Power Industry

THE interdependence of nations and the timeliness of J. Ramsey McDonald's visit to the United States to promote world peace are readily translated into terms of power. We are in the midst of an intense industrial and technical activity.

European developments in high-pressure steam are extending into our public utility and industrial power enterprises. American practices are equally in demand abroad. Even now American engineers are engaged in studies for the raising of the Assouan Dam on the Nile; the building of hydro-electric works in Spain and Russia; and reporting upon water power developments on the northern slope of the Alps in Switzerland and Austria, for transmission into western and central Germany.

United States industries are establishing manufacturing plants in many foreign lands. European manufacturers are spreading their activities into Canada, the United States, South America and elsewhere, as the economic advantages become apparent.

The need for common bases upon which technical and engineering developments may proceed, unhindered by differences of practice, is being met with the establishment of international conferences. The first World Power Conference, held in London during 1924, with others, including the one in Japan this month and another to be held in Berlin during June of next year, illustrate this.

In consequence of these things there has logically followed an international movement of capital and participation of stock interest in industry. The value of these activities and their beneficial effect upon our civilization are unbounded. Yet there are those who view with great concern the incursion of foreign capital into the industry of their countries. As we progress toward world peace and better understand how closely our interests are related, these feelings will disappear.

A Substantial Start on the St. Lawrence Development

PRESIDENT HOOVER'S recent address at the Ohio River ceremonies placed new emphasis on development of the St. Lawrence River as a waterway for ocean-going vessels. No one is in a better position to speak with authority for this project than is the President. Not only is he an engineer and economist of the first rank, but he has been for many years associated with the studies relating to this proposed development, which in addition to providing a deep waterway from

the Great Lakes to the sea involves water power of over five million horsepower.

The St. Lawrence River is no new or suddenly agitated project. An important board, known as the International Waterways Commission, was appointed in 1895 to report upon the feasibility of a deep waterway between the Great Lakes and the sea. Since that time a number of bodies have studied and made reports on the project. The International Joint Commission after an exhaustive study of the engineering and economic features reported favorably for it. Then in 1926 the Joint Board of Engineers presented its report favoring the engineering part of the work.

Although these studies have evolved a general plan of development and have established from an economical and engineering standpoint that the project is feasible, there is still no agreement between this country and Canada as to how and when the work will be undertaken. In both countries many objections have been raised, by various interests. Some have made the claim that the cost will be so prohibitive as to make the undertaking uneconomical. Those beset with the uneconomical bogey will find little satisfaction in the fact that while they expostulate for and against the development one of the most important sections of the work has been started. This is known as the Beauharnois power development, which involves a canal for navigation and power, and a plant that will ultimately have a capacity of two million horsepower. The initial development is for five hundred thousand horsepower, requiring an expenditure of about sixty-five million dollars. This investment represents over twelve per cent of the total estimated cost of developing all the power on the St. Lawrence River. The new plant will go into operation three years hence, and even if nothing further is done in the meantime, its completion will bring one of the three important sections of the river's development into actual operation, and done by private capital. When private capital is willing to back the project, it is good proof of its being economical.

What Is a Plant Engineer?

TITLES have little meaning. In times past chief engineer generally meant the engineer in charge of the power plant. Now it is more commonly the designation of the chief draftsman or the head designer. Industrial power plants are as often as not in charge of a man called the superintendent, or supervisor, of power; while central stations intrust their destinies to a superintendent of generation, or in some cases a chief operating engineer.

Confusion is an unfortunate result of this variety of titles. It is difficult, indeed, to tell what a job comprises from the name by which it goes. Take as an example the comparatively new title of plant engineer. When this name first came into use it was as a substitute for master mechanic or maintenance foreman. Now the plant engineer may include among his duties any or all of the functions in an industrial plant below those of works manager. Frequently the plant engineer is in charge of power as well as maintenance, machine installation and plant housekeeping. As frequently, he has very little or nothing to do with the control of power in his plant.

In an effort to clarify this situation, the Plant Engineers' Club, of Boston, prepared a chart of the duties of plant engineers, which *Power* published last year. Our contemporary journal, *Industrial Engineering,* has contributed much to the determination of the scope of this title, and so have many others.

In spite of this, however, there is still much confusion about plant engineers, each industrial plant tending to use the title solely in the light of its own organization's needs. Since many of its readers are directly concerned, *Power* would like to aid in determining just what the plant engineer's job will eventually be. Any readers with information that will help to do this will aid a good cause by taking a few minutes to put their views on paper and send them in.

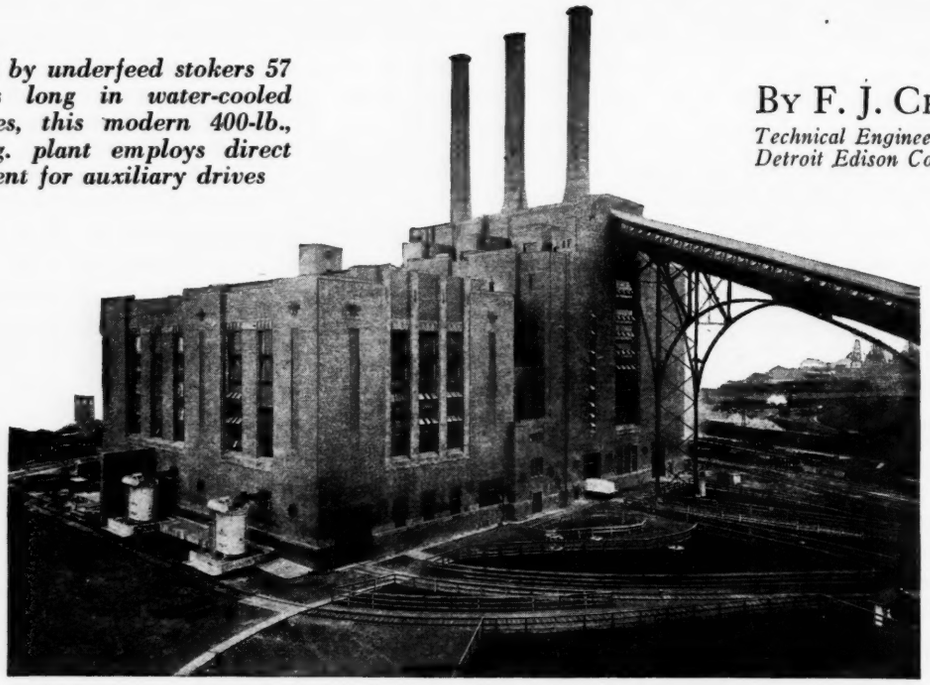
Engineering or Expediency?

TOO often engineers are encountered who feel under the necessity of apologizing for their plants. They realize fully that supplying the kind and quantity of power plant services that they do, desirable economies could be made by generating all services required in their own plants by means of well-designed efficient equipment. But, for one reason or another, this course is not followed.

An example of this was noted recently in the case of a new boiler plant serving an industry where the process steam load was fully adequate to permit all needed power to be generated as a byproduct. This concern, in designing the new installation, had made allowances for the installation of turbine-generator sets. However, it was brought to its attention that one of its directors was prominent in the local power company management. Without any request from him, in fact without his knowledge, the turbine-generators were not installed and a contract was made with the utility for the power requirements. The change was made because it was thought inexpedient to run the risk of offending an influential man. However, should he ever discover that, out of a too-tender solicitude for his other business interests, his company had made him the innocent cause of a $45,000-yearly waste, he would have good cause to be offended.

This is only one instance. Others could also be cited in which a mistaken idea of expediency has been allowed to supersede good engineering to the detriment of economy. Proper engineering squarely faces dollar and cents reality, regardless of business expediency. With such an attitude, the engineer need never be ashamed of his works.

Served by underfeed stokers 57 tuyeres long in water-cooled furnaces, this modern 400-lb., 700-deg. plant employs direct current for auxiliary drives



By F. J. Chatel
Technical Engineer, Delray, Detroit Edison Company

New 100,000-Kw.
Delray Power Plant
Placed in Operation

When cinders were used from Delray power houses No. 1 and No. 2 to fill in low ground, then for the most part under water, along the Detroit River waterfront, valuable land was reclaimed for coal storage space by the Detroit Edison Company. Well within the city limits, and strategically located with respect to the company's underground transmission system, this filled-in land soon became too valuable as a power plant site to be used any longer for coal storage. And so it was here that the new Delray power house No. 3 was located. The new plant is entirely independent of the other two. Owing to the bad reputation of the sub-soil in the River Rouge vicinity, it was decided to erect the plant on caissons, which rest on rock at an average depth of 95 feet.

The plant is being built in sections, later additions to extend toward the river. The intake canal that served the older power houses was widened from its source to a new screen house, from which intake canals lead to the new plant. The overflow canal running lengthwise beneath the new plant has been incorporated in the sub-structure of the building and widened to accommodate the additional water flow. New coal-handling buildings and apparatus have been constructed and a dock built at the riverfront for receiving coal by self-unloading lake barges.

Although the present, first, section is equipped for stokers, the boiler-room steel work is designed to make possible the installation of some form of pulverized coal firing should a change of conditions ever warrant it. The turbine-generators are remotely controlled, the Waterman switch house on West Jefferson Ave., at the extreme northern end of the Delray property, having been enlarged for this purpose. Outdoor transformers are installed on a mat immediately adjacent to the turbine room.

Standard 50,000-Kw. Units Installed

It was considered advisable for the present to install 50,000-kw. turbine-generators essentially the same as those at the Trenton Channel plant. This was done primarily from the viewpoints of known satisfactory performance and the availability of spare parts, including a spare turbine rotor, which are applicable to any of these units. Two of these units are now installed in the new plant. A third will be installed at Delray early in 1931, and another in the near future at the company's Marysville plant. This will make a total of ten turbines that will have interchangeable rotors. Present plans call for the ultimate installation of six, or possibly seven, of these units or their equivalent in other sizes if changes in turbine design or performance warrant it.

Steam is extracted from four stages in these machines, as compared with three in the older installations. The addition of the fourth stage of heating reflects the introduction of air preheaters in the plant. This, however, is mainly a casing change and does not materially affect the spare turbine parts kept on hand. The governor arm is constructed so that the overload valve can be controlled automatically by the governor or can be disconnected from it by a latch connected over a fixed post. The purpose of this is to avoid operating in the capacity range above the point of maximum efficiency. The turbine has 21 stages and operates at a speed of 1,200 r.p.m. Extraction is from the ninth, thirteenth, sixteenth and nineteenth stages.

The generator voltage, 12,200, is stepped up to a bus voltage of 24,000 by auto-transformers connected individually to each generator. The generator air is cooled by a two-pass fin-type air cooler.

Exhaust steam is condensed in single-pass condensers having 60,000 sq.ft. of surface, amounting to 1.2 sq.ft. per kilowatt. Compared to earlier installations in Detroit, this amount of surface is high, but is considered necessary because of the large amount of foreign matter in the river water at Delray. One-inch No. 18 gage tubes, 24 ft. long, are used in these condensers. From a metallurgical study of the tube composition made in 1914, it was found that with specified grain structures, tubes of 70 per cent copper and 30 per cent zinc, or, as a slight variant, Admiralty metal, were best suited for water conditions in the Great Lakes. Tubes of this composition are rolled into the tube sheet at the water inlet and secured with Allen packing at the discharge end. This results in a low water-entrance loss and allows expansion of the tubes at the packed end.

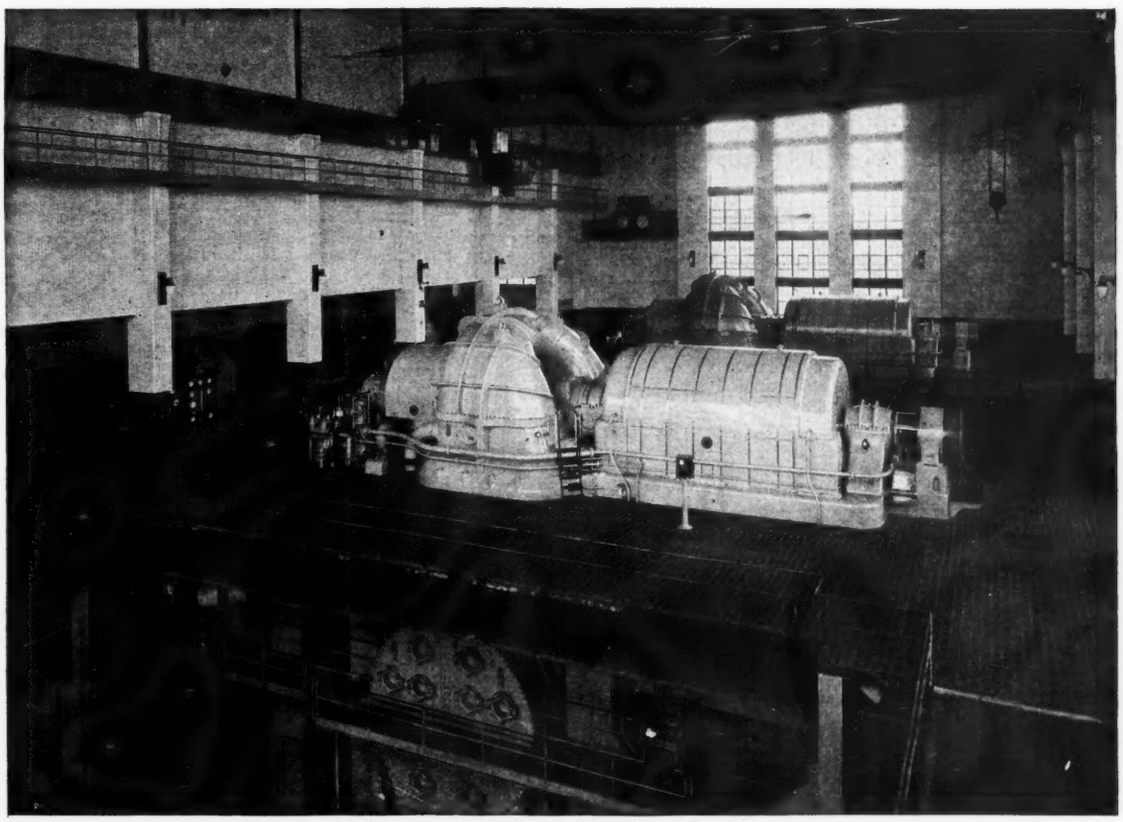
Although it can be shown by calculation that direct-current auxiliaries are not the most economical from the standpoint of coal consumption, it is believed that their inherent flexibility of control results in enough improvement of operation to overcome any possible disadvantage in either initial or operating costs. It was decided, therefore, to drive all continuously operating auxiliary machinery by direct current, which makes possible the use of simple adjustable-speed motors whenever the character of the load makes this desirable.

Having in mind the difficulties that are known to have existed in the past in cases of plant shutdowns, it was decided to install auxiliary turbine-generators with their own condensers and auxiliaries, and to make them mechanically and electrically independent of the main units.

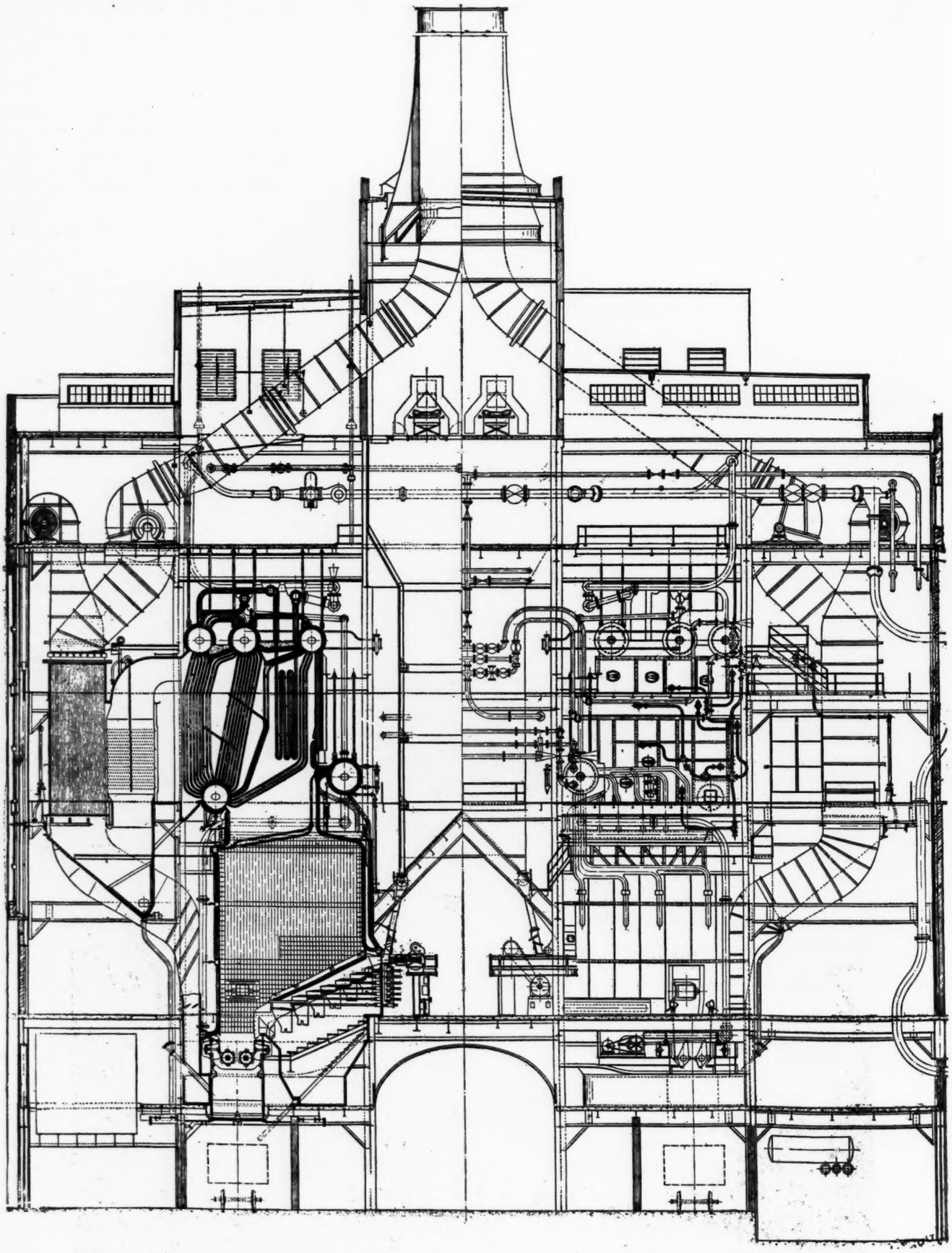
To furnish this auxiliary power, two 4,000-kw. direct-current turbine-generators are ready for service and a third similar unit will be installed in the near future. The tandem generators of each unit are driven by a compound turbine through reduction gears. The exhaust steam is condensed in two-pass condensers. Steam is extracted from the fourth stage of the high-pressure turbine for the building-heating system. All auxiliaries for these units are driven by direct-current motors.

Main Unit Auxiliaries

Cooling water for the main condensers is supplied by two 48-in. centrifugal pumps driven by 150- to 400-hp. adjustable-speed, direct-current motors. Operating simultaneously, the two pumps deliver 120,000 gal. per min. Connection is made at the condenser inlet water box for the cooling-water supply to the generator air cooler. Long years of experience with the rotative dry vacuum pump, its excellent performance under high-vacuum conditions and its adaptability to the operations of priming circulators and starting up, determined the choice. The problem of space limitations was met by the



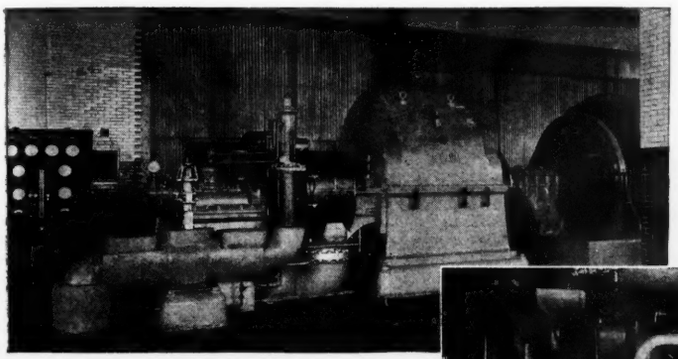
Two 50,000-kw. turbine-generators are now in operation

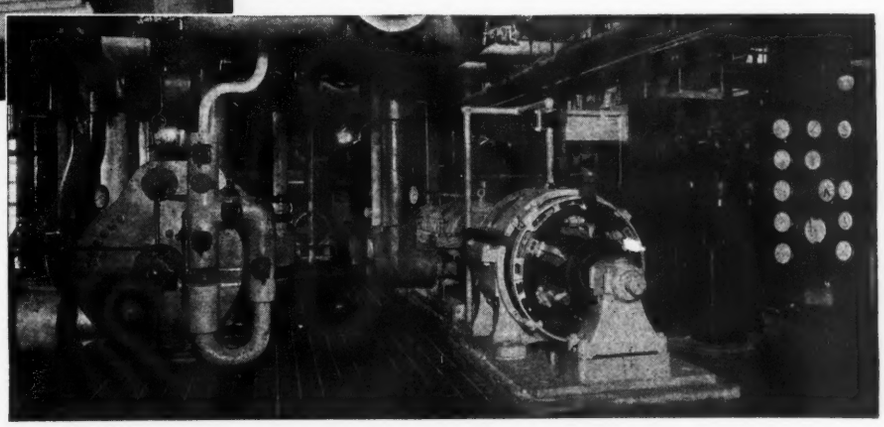


Combination Stirling-type and screen boilers, with water-cooled furnaces, 57-tuyere stokers, economizers and air preheaters feature the boiler-room equipment

installation of the vertical type of pump. Each unit has one dry vacuum pump driven by a 14- to 66-hp. adjustable-speed motor. The pumps are inter-connected by a header for emergencies.

From the diagram of steam and feed-water cycles, the course of the condensate from the hot-well to the main boiler-feed line can be followed. A slow-speed motor-driven lift pump ahead of the main hot-well pump raises the condensate from vacuum to approximately atmospheric pressure. The so-called hot-well pump itself is simply a booster, with its impeller mounted on an extension of the boiler-feed pump shaft. The complete main unit consists, therefore, of the lift pump, separately driven, and the tandem coupled hot-well and boiler-feed pumps driven by a 425- to 700-hp. adjustable-speed motor. The lift pump reduces the power requirements about 10 per cent and removes all possibility of cavitation in the pump impellers of the higher-speed motor-driven tandem units. The auxiliary boiler feed pump, with the hot-well pump likewise coupled to the same shaft, is driven by an 800-hp. steam turbine. In this case, however, the hot-well pump takes its suction directly from the main condenser without the interposition of a lift pump.





Above—Direct-current 4,000-kw. house service turbine-generator

Right—Tandem-coupled boiler-feed and hot-well pumps, steam and electric driven

In both cases the hot-well pump delivers its water to the boiler-feed suction after passing it through the nineteenth- sixteenth- and thirteenth-stage extraction heaters at a temperature, leaving the thirteenth-stage heater, of from 250 to 275 deg. F. The main boiler-feed pump delivers the water through the ninth-stage high-pressure heater into the feed main at a temperature of 340 deg. F. at 50,000-kw. turbine load. The auxiliary boiler-feed pump, to be used only in emergencies, will deliver water directly to the feed lines, ordinarily bypassing the ninth-stage heater for the sake of simplicity.

The boilers are of the single-ended type, designed for a maximum evaporation of 340,000 lb. steam per hour, at 400 lb gage superheater outlet pressure and 700 deg. F. total temperature. These units consist of a main convection boiler, closely resembling the ordinary Stirling type, under which is an independent screen boiler consisting of four water walls and one bank of tubes crossing the top of the furnace. The latter tubes, with several tubes of the main boiler, act as a screen for the superheater. This screen boiler, which with the fuel bed entirely incloses the furnace, is fed independently of the main boiler and has its own independent circulation. Steam is delivered from it through non-return valves to the rear steam drum of the main boiler, thus obviating the necessity of a separately organized superheater. The convection boiler is designed for a working steam pressure of 455 lb. gage.

Boilers of higher pressure were given considerable thought, but the final decision was determined by the type of boiler and the limitations imposed by riveted drum construction and required plate thickness. Furthermore, with the superheated steam temperature arbitrarily set at 700 deg. F., this pressure approaches the maximum practicable for a turbine operating on a simple regenerative steam cycle without reheat.

Although the first section of the boiler room is built to accommodate six of these boilers, five will be erected at present. A separately fired superheater will be placed in the sixth position to serve the 10,000-kw. British Thomson-Houston high-temperature turbine to be located near by. This experimental turbine installation was described by J. W. Parker in the May 28 number of *Power*.

Gases leaving the convection boiler pass downward through a wrought-steel return-bend economizer of 6,032 sq.ft. of surface. Reversing the direction of flow, the gases flow upward through a vertical-tube air preheater of 26,920 sq.ft. of surface. The gases are handled by a double-inlet induced-draft fan with a capacity of 223,000 cu.ft. per minute and 13.9 in. static pressure. Air is forced through the preheater by two forced-draft fans per boiler, mounted on opposite ends of a single driving motor. The blowers and induced-draft fans are driven by direct-current adjustable-speed motors having both armature and field control. The pipe gallery is located over the boilers. With the main steam and boiler-feed lines supported overhead, a room at this elevation afforded an excellent location for the fans and blowers. The air supply, taken from this room and from openings through the floor, absorbs heat radiated from the steam mains and boiler units.

15-Retort 57-Tuyere Underfeed Stokers

The stokers are of the underfeed U-type, capable of burning from 3 to 17 tons of coal per hour on a projected grate area of 611 sq.ft. The length of the furnace is

such that it necessitated the unusual length of 57 tuyeres to the stack. There are 15 retorts divided into 5 sections, each section served by a two-speed power box. The 4-to-1 motor-speed ratio, double supply voltage and power box reductions result in a 12-to-1 crankshaft speed range. Six sets of pushers, operated in conjunction with each ram and through bell cranks, serve to push the burning coal, coke and ashes toward the extension grates, which also are movable. The shape and thickness of the fuel bed is regulated by adjustments, made externally, of the pusher and extension grate strokes. Clinkers are ground by two 26-in. grinder rolls having a speed range of from one revolution in nine hours to three revolutions per hour.

A belt of Bailey blocks surrounds the furnace, and extends to a point well above the maximum fuel bed height. Above this belt the wall tubes are bare. High side-wall tuyeres, air-cooled, form the connecting link between the stoker and the side walls. Grid bar boxes and air-cooled ram box caps in the front wall supply air to the coal entering the furnace. Heat will be liberated at the rate of 32,000 B.t.u. per hour per cubic foot of furnace volume. As a means of minimizing coal dust in the boiler room, individual coal chutes equipped with coal valves and tight-fitting access doors for coal sampling are extended to the hopper of each ram box.

Owing to the length of the stoker and the limited number of observation doors, minimized to avoid interference with the water wall tubes, it will be difficult to detect thin or heavy spots in all sections of the fuel bed, particularly near the top and center. To obtain proper and more timely air regulation to all sections of the fuel bed, automatic air control dampers are being developed and installed.

The savings effected by water-borne coal at the Marysville plant led to the installation here of an unloading

Principal Equipment Delray Power House No. 3

Turbine Room

Main Units—Two 50,000-kw., at 0.8 power factor, 12,200-volt, 1,200-r.p.m. 21-stage turbine, bled at 4 points; direct-connected exciter, 300 kw., 250 volts ..... General Electric Co.
Auxiliary Units—Two 4,000 kw., 250-volts, 360-r.p.m., direct-current generators, Crocker Wheeler Elec. Mfg. Co.
Turbines, two compound-condensing, 375 lb., 29-in. vacuum, 4,000 r.p.m. and 3,000 r.p.m., DeLaval Steam Turbine Co.
Auto-transformers (main unit), two 12,200 to 24,000 volts, 75,000 kva. ..... General Electric Co.
Condensers, Main—Single-pass, 60,000 sq.ft., Worthington Pump & Mach. Corp.
Auxiliary—two-pass, 7,500 sq.ft., Worthington Pump & Mach. Corp.
Circulators, Main—Two per condenser, 48-in. volute pump, two in operation, 120,000 g.p.m.; General Electric d.-c. motor, 150 to 400 hp., 175 to 240 r.p.m. ..... Worthington Pump & Mach. Corp.
Auxiliary—One per condenser, 20-in. volute pump, 10,000 g.p.m.; General Electric d.-c. motor, 37 to 60 hp., 215 to 435 r.p.m. Worthington Pump & Mach. Corp.
Dry Vacuum Pumps, Main—One per condenser, 35x18-in. feather valve; General Electric d.-c. motor, 14 to 66 hp., 60 to 150 r.p.m., Worthington Pump & Mach. Corp.
Auxiliary—One per condenser, 21x14-in., feather valve; General Electric d.-c. motor, 12 to 25 hp., 60 to 125 r.p.m. ..... Worthington Pump & Mach. Corp.
Oil coolers, two per turbine unit ..... Andale Co.
Oil separators, one per turbine unit. DeLaval Separator Co.
Generator air coolers, one per main unit, Griscom-Russell Co.

Boiler Room Equipment

Boilers, Main—Five, special Stirling single-ended bent water-tube type, 455 lb. per sq.in., g.; capacity 340,000 lb. per hr., 23,900 sq.ft. surface, Babcock & Wilcox Co.
Screen—Effective bare wall tube surface 2,044 sq.ft.; Bailey block surface, 1,456 sq.ft.; furnace volume 13,800 cu.ft.; heat release 32,000 B.t.u. per hr. per cu.ft. ..... Babcock & Wilcox Co.
Superheaters, B. & W. hairpin convection type, 4,900 sq.ft. surface, 700 deg. F. steam temperature, Babcock & Wilcox Co.
Economizers, wrought-steel, return-bend, horizontal, bare-tube counterflow type, 6,032 sq.ft. surface ..... Babcock & Wilcox Co.
Air preheaters, vertical, bare-tube type, 26,920 sq.ft. surface, 350 deg. F. maximum temperature, Babcock & Wilcox Co.
Stokers, five, Taylor underfeed type, 15 retorts, 57 tuyeres, 611 sq.ft. grate area; capacity 34,000 lb. per hr. of coal; General Electric d.-c. motor, 17.5 to 35 hp., 500 to 2,000 r.p.m.; 240 to 120 volts; clinker grinders, two rolls 26 in. diameter, 1/9 to 3 rev. per hr., two General Electric d.-c. motors, 2.5 to 5 hp. ..... American Engineering Co.
Forced-draft fans, two per boiler, double-inlet superduplex conoidal types; capacity 65,000 c.f.m. at 70 deg. F., 12.5 in. static pressure; General Electric d.-c. motor, 50 to 400-hp., 450 to 925 r.p.m., Buffalo Forge Co.
Induced-draft fans, double-inlet super-duplex conoidal type, capacity 223,000 c.f.m. at 350 deg. F., 13.9 in. static pressure; General Electric d.-c. motor, 80 to 700 hp., 450 to 925 r.p.m. Buffalo Forge Co.
Feed-water regulators, two per boiler, Copes ..... Northern Equipment Co.
Soot blowers ..... Diamond Power Specialty Corp.
Pressure-reducing valves, two 3-in., 400 to 200 lb., Boylston Steam Specialty Co.
Safety valves, 14 per boiler, Consolidated Ashcroft Hancock Co.
Blowoff valves, four per boiler... J. Hopkinson & Co., Ltd.
Water columns, four per boiler..... Yarnall Waring Co.
Valves ..... Chapman Valve Mfg. Co.

Coal-Handling Equipment

Breaker, Bradford type, 12x22 ft., 14 r.p.m., 525 tons per hr.; General Electric a.-c. motor, 150 hp., 720 r.p.m. ..... Pennsylvania Crusher Co.
Conveyors, belt and pan ..... Link Belt Co.
Motors ..... General Electric Co.
Reduction gearing for conveyors, DeLaval Steam Turbine Co.
Car tipper, capacity fifteen 120-ton cars per hour; General Electric a.-c. motor, 80 hp., Wellman-Seaver-Morgan Co.
Coal loader, cable drag-line scraper.. R. H. Beaumont Co.
Dust collecting, Dracco bag filters, Dust Recovering & Collecting Co.

Feed-Water System

Stage heaters, four per main unit, four-pass condenser type, 650,000 lb. per hr..... Griscom-Russell Co.
Evaporators, one per main unit, Reilly horizontal floating head, submerged low-pressure type, 12,500 lb. per hr. ..... Griscom-Russell Co.
Storage tanks, three, welded-steel construction, 54,000 gal. each.
Pumps, combination boiler-feed and hot-well, two per main unit, 1,360-g.p.m., 1,195-ft. head boiler-feed pump; 1,500-g.p.m., 290-ft. head hot-well pump; motor-driven unit; Crocker Wheeler d.-c. motor, 425 to 700 hp., 1,000 to 1,200 r.p.m.; turbine-driven unit, 800 hp., 1,650 r.p.m., DeLaval Steam Turbine Co.
Lift pump, one per main unit, 1,500 g.p.m., 35.8 ft. head; General Electric d.-c. motor, 30 hp., 600 r.p.m. ..... DeLaval Steam Turbine Co.
Heater drain pump, one per main unit, 400 g.p.m., 320 ft. head; General Electric d.-c. motor, 15 to 60 hp., 1,200 to 1,800 r.p.m. DeLaval Steam Turbine Co.
Hot drip pumps, two, 250 g.p.m., 125-ft. head; General Electric d.-c. motor, 2 to 15 hp., 920 to 1,840 r.p.m. ..... DeLaval Steam Turbine Co.
Auxiliary unit hot-well pumps, one per unit, 3-in. pump, 160 g.p.m., 95-ft. head; General Electric d.-c. motor, 10 hp., 1,500 r.p.m., Worthington Pump & Mach. Corp.
General service pumps, two, motor-driven, 2,400 g.p.m., 307-ft. head; General Electric d.-c. motor, 175 to 240 hp., 1,200 to 1,700 r.p.m.; one turbine-driven pump as above; turbine 250 hp.; 1,700 r.p.m. ..... DeLaval Steam Turbine Co.

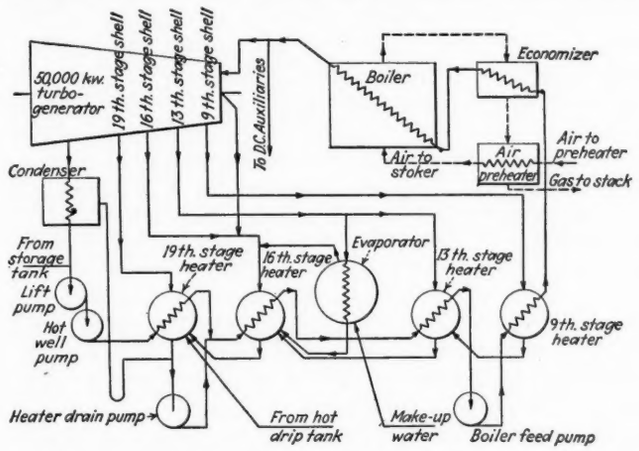
Accessories

Air compressor, 11x19x14-in. two-stage cross-compound, 125 lb. per sq.in., g., 885 c.f.m. free air capacity; direct connected to General Electric 4,800-volt, 225-r.p.m., 200-hp. synchronous motor, Pennsylvania Pump & Compressor Co.
Cranes, turbine room, 125 tons capacity; auxiliary bay, 35 tons capacity ..... Harnischfeger Corp.
Steam traps ..... Armstrong Machine Works
Steam-flow meters ..... Bailey Meter Co.
Venturi water meters ..... Builders Iron Foundry
Draft gages ..... Ellison Draft Gage Co.
Recording temperature gages ..... Foxboro Co.
Pressure gages ..... Consolidated Ashcroft Hancock Co.
CO_2-CO recorders... Bacharach Industrial Instrument Co.

dock and cable drag line scraper for receiving and handling coal by boat. West Virginia and Kentucky coals are freighted to Toledo, Ohio, where they are loaded into coal carriers for direct delivery to the plants. An average boat load of 5,500 tons can be transported from Toledo in eleven hours and can be unloaded in six hours.

A car tripper, capable of handling cars of 120 tons capacity, dumps the coal into the unloading pit, which is in the same building as that housing the coal-handling machinery for power houses No. 1 and No. 2. Tracks for the overhead traveling car unloader, which, with spuds, is used for moving and unloading cars in the old section, have been extended over the new pit at one side of the car tipper. Either unloader may be used over the new pit.

Coal from the pit is carried by two pan conveyors to a Bradford type breaker having a capacity of 525 tons per hour. As a means of keeping the breaker room clean,



Diagrammatic layout of steam and feed-water cycles

a fan circulates air through the breaker, passing it through a cyclone separator, where the larger particles of coal dust are deposited. Fine dust is removed, after it has left the separator, by a set of Draco bag filters, through which passes an amount of air equal to the leakage into the system.

Beneath the breaker are three pan conveyors, which feed the belt conveyors. The center one supplies coal to the old plants in emergencies. The other two feed the belt conveyors to the new plant. These belt conveyors carry the coal 455 ft., at an angle of 19 deg., up a bridge connecting the breaker house with the new plant. The coal is dumped into a hopper, from which it is delivered by distribution belts to the bunkers. Traveling trippers over each belt discharge the coal into three 1,000-ton bunkers. Coal is distributed evenly in the bunkers through openings extending over their entire length.

Important Features Summarized

The important features of Delray power house No. 3 may be restated as follows: It is a moderate-pressure plant, 400 lb., designed to give a fair balance between thermal economy and cost per kilowatt of installed capacity. It is located in the heart of the district which it serves and has the further advantage of the use of water-borne coal for a part of its requirements. Air preheaters, water-cooled furnaces, and automatic air control with an improved type of stoker should contribute to flexibility and economy of operation in the boiler room. The main turbine-generators having rotors interchangeable with those of other units in the system, direct-current auxiliaries, and regeneration in four stages will make for reliability and economy in the turbine room.

The plant has been in operation for several months and promises to be a practicable installation from an operating standpoint. Just what economies will be realized cannot be determined until the results of at least twelve months' operation are available. The first turbine-generator went on the line Aug. 19, with two boilers available. The second unit was placed in service Sept. 3. Both units are now operating with three available boilers.

Accidents to Engineers

By Arthur L. H. Street

A NIGHT engineer in a steam power plant in Arkansas was killed by a bursting flywheel when the engine "ran away." His widow's suit for damages against the employer raised questions concerning the employer's liability, considering relative opportunities for discovering the defective condition that presumably caused the accident—failure of a governor belt to function.

The United States District Court for the Eastern District of Arkansas allowed judgment in the widow's favor and the United States Circuit Court of Appeals upheld the award. (Chicago Mill & Lumber Co. vs. Jett, 32 Fed. 2d, 976.)

The higher court held that the evidence in the case was such as to warrant the jury in finding that grease had been permitted to accumulate on the belt in such position as to cause the belt to slip on starting of the engine, and that by reason of the time that this condition had continued and of the fact that complaints had been made to the assistant master mechanic by others, there was negligence on the part of the employer in failing to remedy the condition before the accident.

And it was decided that the circumstances were such that the deceased engineer was excusably ignorant of the condition of the belt, because it was only in the starting of the engine that the belt was apt to slip, and he had not previously had occasion to start the engine while the belt was in defective condition. Therefore, not having known of the risk to which he was exposed, he could not be held to have assumed it.

Powdered Coke Found Practicable

THE question of the relative value of powdered low-temperature coke as compared with coal has been investigated at the Pittsburgh experiment station of the United States Bureau of Mines. To be sure, it has been found that the rate at which a flame travels through a cloud of low-temperature coke dust is less than for coal dust. The rate is, however, still rapid enough to permit ready ignition of the coke dust in a furnace.

A further investigation was directed toward determining the relative rates at which particles of coke dust and coal dust burn after once having been ignited, for this determines the rate at which the burning particles will liberate heat in the furnace. It was found that the rate of burning of the low-temperature coke particles is quite comparable with that for coal under similar conditions. It was shown that the powdered low-temperature coke has a definite advantage over powdered coal in that the former is much less liable to spontaneous ignition than the latter, and can probably be stored with safety.

Industrial Water Treatment

II—Zeolite Softeners

By George Cawley
Montclair, N. J.

THE zeolites used in the base-exchange type of softener present the paradox of an insoluble reagent for effecting changes in solutions. These zeolites are complex silica compounds that have the power of exchanging the bases of dissolved compounds in contact with them. Suppose, for instance, that we have a zeolite that is ready to exchange sodium atoms for some other metallic atoms, then the reaction goes as per the following equation (NaZe representing the zeolite in its first condition):

$$2\ NaZe + Ca(HCO_3)_2 \leftrightarrows 2\ NaHCO_3 + Ca(Ze)_2$$

or

$$2\ NaZe + MgSO_4 \leftrightarrows Na_2SO_4 + Mg(Ze)_2$$

Quite a number of similar equations could be written. The sodium atoms may be imagined as massed at the edges of the complex molecular structure ready to force the bases from the dissolved salt molecules. The displaced bases, having no other place to go, take those left by the sodium atoms.

An important feature of this reaction, as far as calcium and magnesium are concerned, is that the reaction may be reversed by using a strong soda solution on a zeolite containing calcium and magnesium. It is thus possible to use the mineral over and over again by placing the "exhausted" mineral in contact with a soda solution. This is known as reconditioning or regeneration. It must be noted that the acid radical of the soda compound used must make soluble calcium and magnesium salts. Fortunately, common salt, NaCl, fulfills the requirements of cheapness, ease of handling, and solubility of the calcium and magnesium salts removed from the exhausted zeolite.

It will be seen that the passage of a hard water through the zeolite bed does not change the number of molecules of dissolved solids, it simply changes the bases of certain of the salts in solution. It might be noted here that a water containing large amounts of sodium salts as well as hardness is with difficulty completely softened, because the soda salts originally in the water plus the soda exchanged out from the zeolite tends to reduce the mass action of the sodium atoms in the zeolite molecule. However, since the mineral is insoluble it may be provided in sufficient excess to soften a nominal raw water so close to "zero hardness" that any commercial test would show the entire absence of calcium and magnesium.

In commercial practice the bed of zeolite is not permitted to absorb all the hardness that it is capable of doing. This restriction of the capacity of the mineral is due to the fact that too great an accumulation of calcium and magnesium in the softener requires an excessive amount of salt for regeneration on a basis of so much salt per thousand grains of hardness removed from the raw water. It is also necessary to provide overload capacity to allow for the variations in chemical content that are bound to occur in natural waters.

The capacities of various zeolites are rated in grains of hardness removed before regeneration is necessary, the cubic foot being the unit. It has been found that volume is a safer measure than weight, because of the fluctuation in water content of the material. It will thus be seen that the capacity of a softener in gallons is inversely proportional to the hardness of the raw water, this of course being subject to certain modifications.

If a water is excessively hard, the first part of the bed increases the soda content of the water reaching successive parts; and, as explained before, this tends to retard the exchange of sodium for calcium and magnesium. In cases such as this it is necessary to increase the amount of mineral to produce soft water. Some of the synthetic minerals exhibit a selective action towards calcium, so that their capacity for exchanging magnesium is about one-half that of the calcium exchange value.

In the October 22nd number of *Power* Mr. Cawley discussed filtration and lime-soda plants. In this concluding article he explains the underlying principles of zeolite softening and gives practical pointers on the selection and operation of zeolite systems.

The earliest commercial zeolites were those produced by Gans, and were complex alumina-silicates. They had a porous structure, a high exchange value and were comparatively light.

After the introduction of the synthetic material into this country a zeolite was produced from a South Dakota clay by means of caustic treatment, extrusion and baking. The result was a granular material, of light red-brown color. The individual grains had a compact core surrounded by a porous coat, which was the active part. These granules were, perhaps, $\frac{1}{10}$ in. in diameter and $\frac{1}{8}$ in. long. The exchange value was somewhere between the synthetic material and the green sand zeolite.

Borrowman, in this country, introduced the mineral made from glauconite, or green sand. Wet and dry processes were developed for making the raw material available for water softening. The finished material is dark green to black in color, fine-grained, heavier than the Gans material and non-porous. Green sand zeolites

have not the exchange value per cubic foot that the porous Gans material had, but can be regenerated much faster and can soften water at a higher rate. They are also cheaper to produce. The usual regeneration time of the synthetic material was overnight, with a minimum of six hours, which latter procedure reduced the exchange value somewhat. The green sand material can be regenerated in less than a half hour.

Because of its resistance to high CO_2 content in the water, excess organic matter and iron, compared with the synthetic material, green sand zeolites have largely displaced the former, as purchasers found that the quick regeneration and high-rate characteristics of green sand enabled them to procure a plant at less initial outlay and with no higher operating costs. Recently a synthetic zeolite, a type of silica gel, has been put on the market which is claimed to have high exchange value, quickness of regeneration and resistance to wastage.

Nearly all zeolite plants are provided with a meter for totaling the amount of water softened, the usual practice being to regenerate the softener after a specified number of gallons has been passed through the softener, regardless of minor fluctuations in the composition of the raw water. To take advantage of the full exchange power of the bed would require analysis of the water at frequent intervals, and the changing of the length of run with each variation in the water analysis. This, in most cases, would be much more trouble than the saving in salt would warrant.

The zeolite softener consists, essentially, of a cylindrical pressure tank whose axis may be either horizontal or vertical, a tank for making up the brine solution, and the necessary piping valves and meters. The zeolite bed rests, as a rule, on gravel arranged like the gravel bed under a sand filter bed and has a strainer system under the gravel bed. In some types of softeners the water passes downward through the bed, in others it flows upward. The brine in regenerating may be withdrawn from the bottom of the container or it may be admitted in the bottom and withdrawn from the top. The use of different methods of passing the brine through the softener has been at the dictation of the patent situation rather than because of technical reasons, this applying equally well to the direction of flow of water through the softener.

Various methods for handling the regenerating brine have been used. In earlier softeners the brine was siphoned through, the solution being of from 5 to 10 per cent strength. Lately, for green sand softeners the brine has been made up by allowing the water for the solution to remain in contact with a large amount of salt, a nearly saturated brine forming at the bottom of the tank. A water ejector serves the double purpose of introducing and diluting this concentrated salt solution.

After regeneration, the brine must be completely rinsed out of the bed before the effluent of the softener is allowed to run into the soft water lines. This step is known as "rinsing." The end point of this operation is determined by soap test or by absence of salt taste in the water.

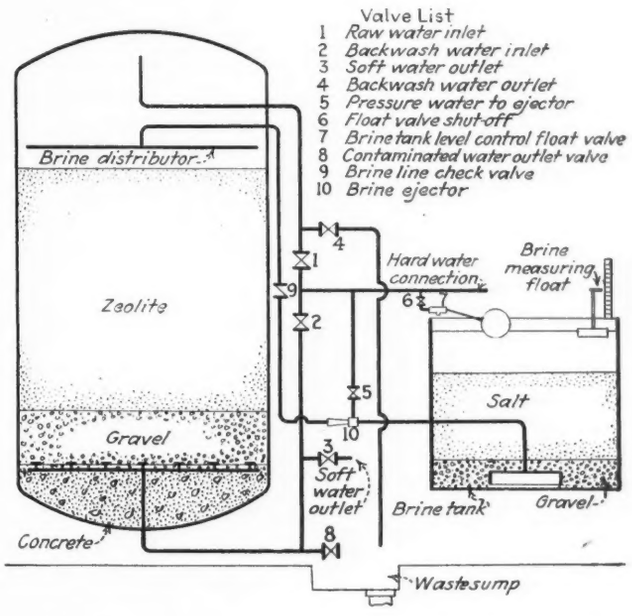
Although the softening apparatus is quite similar to that used for filtration, it is obvious that the action of the zeolite mineral is different from that of the sand bed. In the latter, the work is done at or near the top surface; while in softening, each part of the whole bed must do its share of the work.

Since the exchange power of zeolites is a matter of surface contact between the water and the mineral, it follows that the hard water must be reasonably clear. Therefore, where waters are turbid they should be filtered; employing settling and coagulation before filtering, if necessary. This is particularly true where porous zeolites are used

Purification by Evaporators

While water softening is generally considered as a strictly chemical process, we may include distillation in our discussion of apparatus for the removal of hardness. Except for small quantities, the ordinary form of distillation is often too expensive an operation for commercial water-rectification purposes. In special cases a process may have a heat balance that permits the economical use of distillation for fairly large quantities of water. The distilled-water ice plant is an example of this, since the steam used in the engines is condensed and freed from oil to give suitable water for the ice cans. At present, the raw-water ice plant is coming to the fore, eliminating somewhat the distilled-water type of purification plant.

As in the case of the distilled-water ice plant, a favorable heat balance may permit the use of evaporation for purifying large quantities of water, and this obtains in large steam stations using surface condensers. The raw water is evaporated at such a pressure that the distillate may be condensed by the condensate from the main condensers. Thus the heat used to evaporate the raw water is returned to the general feed-water stream, the only heat lost being that due to radiation. This latter,



Typical zeolite softener, arranged for downward softening, rinsing and reconditioning

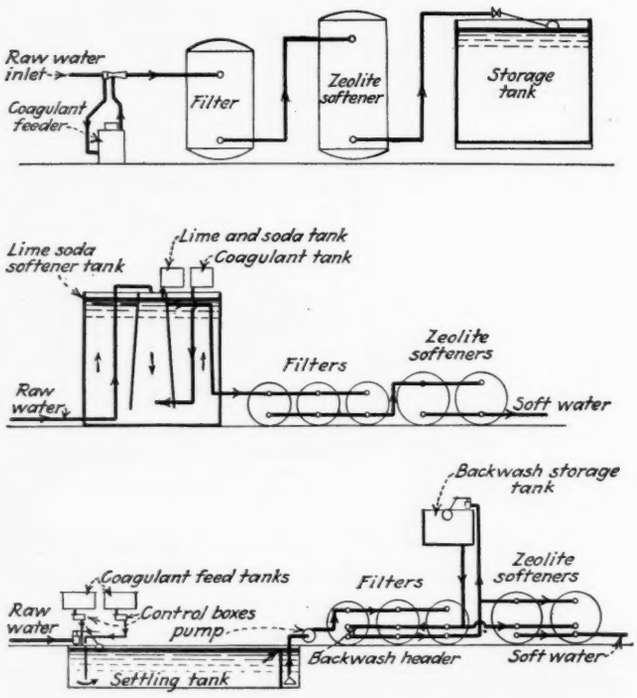
however, should be guarded against, as it may prove to be a big item.

Most of these evaporator systems are built so that scale may be cracked from the evaporator coils by running cold water through them. Protection against foaming and priming is provided, but some solids are usually found in the distilled water. However this type of plant effects a reduction in total solids that cannot be approached by other purification plants.

It is impossible to designate any type of rectification plant as generally the best. Each plant has its own

particular sphere of usefulness. It often happens that a combination of two or more softeners produces results not to be obtained from a single type alone. Where the raw water is high in bicarbonates and a very soft water is required, a lime-soda-zeolite plant will give a water that is not only low in hardness but one in which the total solids are lower than the raw water. Also the initial cost of the plant will generally be less than that of an all-zeolite plant of equal capacity. Some power stations are finding that the zeolite plant is an important aid to evaporator operation, and so install the zeolite-evaporator. Special operating conditions may indicate other combinations.

It will be seen that the proper solution of a water problem involves consideration of the character of the water supply, degree of purity required in the treated water, space and funds available for the apparatus, and the operating conditions at the plant. In many cases considerable study of a water supply is necessary for an accurate estimate of its character, because of possible fluctuations in both suspended and in dissolved impurities. It is often necessary to balance the ultimate cost of treating a private supply as against a public one, taking into consideration the cost of pumping, chemicals, intakes, etc., as against city charges. In considering combination plants, the question of repumping the water should be looked into, as it affects the cost of treatment. The city water supply may be at high pressure constantly, or during bad fires, a condition to be provided for. Often need for enlarging the plant later on is overlooked, and considerable trouble results when the demand for treated water increases. It is well to get all the advice possible when a large water-purification project is under consideration.



Typical combination plants (chemical feeds are often omitted before filters where water is not very turbid. Soft-water storage may be avoided by using more than one softener unit)

Top—Pressure coagulant feed, filter, softener plant with storage tank to handle regeneration periods. Center—Combination of zeolite and cold, continuous lime-soda treatment. Bottom—Zeolite plant with coagulant feed, settling, filters and storage for filtered backwash water.

The highest types of filter plants are the only means mentioned in the foregoing that effect any reduction in the bacteria or other organisms in the raw water, but even these are not guaranteed to remove the whole of the organic content in the applied water. As a result, some organisms slip through and are free to reproduce in the filtered water. Where a selective action takes place in the filtering, and this often happens, the survivors, free from many of their natural enemies, thrive so well that the bacterial count in some parts of the filtered water system may be greater than that of the raw water. It has been realized, therefore, that some means must be employed to kill off the surviving organisms.

The most generally used means of ridding water of bacteria, etc., is chlorine. This was first applied by means of bleach (chloride of lime) solution. The manufacture and control of the disinfectant was difficult and unpleasant, due to the sludge which had to be disposed of and the odors that were given off during the preparation of the solution. A later development has been the use of chlorine gas. Reliable and efficient apparatus has been developed for handling the chemical in this form. The chlorine is purchased compressed and liquefied in cylinders and is attached to the chlorinator by simple gas-tight connections, thus eliminating all danger and discomfort.

The disinfectant is often added to the filtered water, because the required dose is less than if added to the raw water. There are some cases where the raw water is dosed before coagulation, sometimes followed by an additional dose in the filtered water.

Ozone is another disinfectant used for sterilizing water. Due to the expense and complication of the apparatus and the difficulty of evenly dissolving the gas throughout the volume of the water to be treated, this method of disinfection has had restricted use.

Ultra-violet light has been used for the killing of bacteria in water. This method offers the advantage that no overdose is possible, but it is subject to the disadvantages of high first cost, the need of a high degree of filtration and color removal for effective sterilization and the fact that the water is not protected against reinfection.

Generating Costs of a Diesel Plant

ACCORDING to C. P. Town, chief engineer of the municipal light plant of Swift Current, Sask., Can., power is generated in its Diesel plant at a cost of 1.757 cents per kilowatt-hour. Here is the record for 1928:

	Unit No. 1	Unit No. 2
Kw.-Hr. generated	731,740	1,086,800
House lights and pumps, kw.-hr	20,600	24,600
Net output, kw.-hr	711,140	1,062,200
Engine running time, hr.	3,835	5,473
Fuel consumption, gal.	70,351	99,147
Lub. oil, gal.	1,391	880

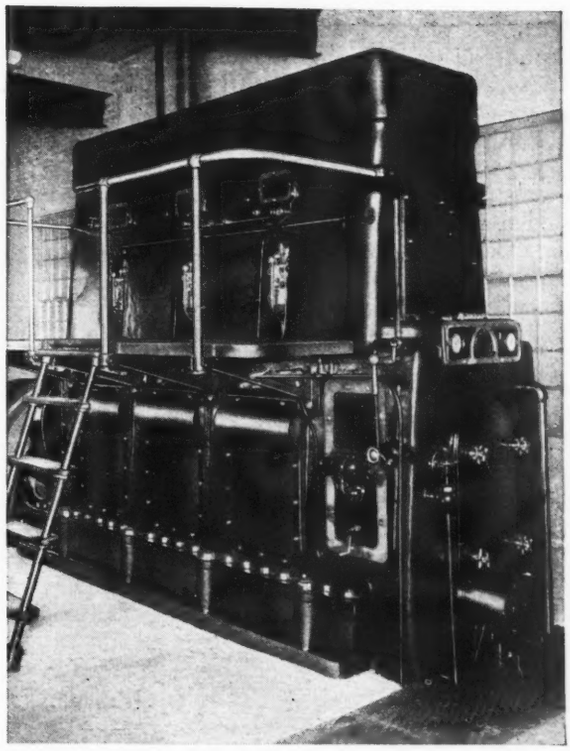
GENERATING COSTS PER KILOWATT HOUR

Fuel oil	$0.00889
Lubricating oil	0.00065
Maintenance	0.00028
Supplies	0.00009
Salaries	0.00646
Insurance	0.60120
Total	$0.01757

Unit No. 1 is a second-hand Diesel purchased in 1918, while the second engine is a 600-hp. Busch-Sulzer Diesel installed in 1926. In 1927 and 1928 the second unit was operated for a total of 10,797 hr. At the end of this period measures revealed that the total crankshaft bearing wear averaged 0.06 in. and 0.05 inches.

COMBUSTION DEVICES of Solid-Injection Diesels

By L. H. Morrison
Associate Editor, *Power*



An inclosed solid-injection Diesel engine

THE greatest development during the last few years in oil-engine design is found in that class usually termed "solid injection"; this type is similar to the air-injection Diesel, save that no compressed air is used to inject the fuel oil. Although these engines make up the greater part of the present output of the many Diesel factories and show marked variation in design, and, for that matter, in behavior, actually they may be divided into three classes.

While we might classify these engines under the heading of two-stroke-cycle and four-stroke-cycle, a better and more logical basis is that of combustion arrangement, and this may then be broken up into a classification based on the fuel-injection systems used by the engines. Furthermore, each of the combustion arrangements give definite and almost invariable operating characteristics to the engine. If one desires to select an engine he will do well to understand the several arrangements, or, shall we say, principles, and their effect on engine operation.

The three general principles are shown in Fig. 1 at *A*, *B* and *C*. That shown at *A* consists of a plain cylinder with a flat head carrying the admission, exhaust and fuel-spray valves. It is, essentially, the identical design of cylinder embodied in practically all Diesels using air injection, and differs in no great measure from a gas engine cylinder. The air is drawn in through the admission valve on the suction stroke, and is compressed on the compression stroke. At the end of this stroke oil is sprayed into the charge of hot compressed air, is ignited by the air temperature, and combustion ensues. The four-stroke-cycle engine shown in Fig. 2 employs the principle outlined in Fig. 1 *A*.

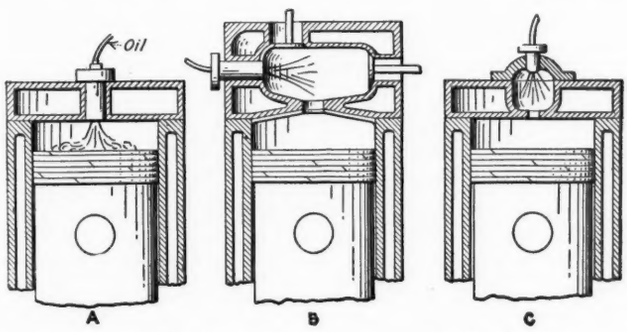


Fig. 1—Three combustion systems used with solid-injection Diesels

With the arrangement shown at Fig. 1 *B*, the cylinder head carries a cavity of a volume sufficient to contain the entire cylinder charge when the piston reaches the end of the compression stroke. Into this cavity the oil is injected, and, mixing with the air charge in the cavity, ignites and burns. Combustion takes place, or should take place, entirely within this cavity, and, as this must occur almost instantaneously and while the piston is at the end of the compression stroke and ready to begin its power stroke, the pressure rises much above the compression pressure. As a matter of fact, combustion is not completed instantaneously, but continues during the early part of the power stroke. This design is incorporated in the four-stroke-cycle cylinder shown in Fig. 3.

At Fig. 1 *C* is shown the so-called precombustion chamber design. In the cylinder head is a small chamber connected to the working cylinder by an orifice, with either a single opening or a multiplicity of small openings.

As the air can flow through the orifice, during the compression stroke the chamber is charged with the hot compressed air and at the proper time fuel is sprayed into this air.

Due to the volumetric limitations of the chamber only a small amount of air is present; this is further decreased by the poor scavenging of the chamber, and only a partial combustion of the oil occurs. The product is, in the main, carbon monoxide, with a minute percentage of carbon dioxide and a varying amount of unburned oil. The pressure rise resulting from the combustion forces the mixture out of the chamber into the working cylinder. Here the carbon monoxide and oil meet sufficient air to burn completely, forming carbon dioxide and water vapor.

Reverting to the plain cylinder design, shown in Fig. 2,

the ignition of the oil spray depends to some extent upon a hot piston crown. If the piston crown is cool, ignition will be slow, combustion imperfect and carbon residue will speedily appear. It is then not surprising that the system is not suitable for two-stroke-cycle engines using exhaust ports and scavenging-air ports arranged so that the cool air sweeps across the piston crown. With but two commercial exceptions the plain cylinder is used exclusively with four-stroke-cycle Diesels. These exceptions are the Doxford opposed-piston engine and the new Burmeister & Wain engine. In the former engine the compression pressure is low, about 330 lb., but the scavenging air enters through ports at one end of the cylinder and sweeps down the bore to blow out the exhaust gases through a set of ports at the other end of the cylinder. The air does not sweep *across* the piston crown; but, to insure a hot piston crown, the Doxford engine employs an insulated steel plate fitted to the center of the piston head.

In the Burmeister & Wain engine the scavenging air enters at the lower end of the cylinder, while the exhaust gases pass out through a piston valve in the cylinder head. The cooling effect of the air is not felt by the center of the piston crown.

In addition to these commercial designs a number of experimental two-stroke-cycle engines with plain cylinder cavities have been built, but results have not been favorable.

Since the piston head is subject to the intense heat of combustion, water-cooling of the piston becomes necessary, as with the air-injection Diesel when the diameter reaches 20 or 22 in., and sometimes when a lesser piston diameter is used.

It is necessary to break up the fuel, or atomize it, as perfectly as is done by air-injection. A coarse spray will invariably lead to carbon deposits, a smoky exhaust and other objectionable operating characteristics.

For this reason the design of atomizer or fuel nozzle demands careful consideration. As the fuel must be well-distributed, the general practice is to employ a five-hole orifice to spread the oil in five streams, or a single central orifice and force the oil along a helix, so that it has a circular motion when it emerges from the orifice. Both spring-loaded and mechanically operated needle-valve designs of nozzles are used, the latter more generally, especially for large engines.

The combustion chamber shown in Fig. 1 at *B* is used exclusively with four-stroke-cycle engines, although several semi-Diesels burn a major part of the fuel in a combustion chamber. The admission and exhaust valves are in the combustion chamber, as are also the spray nozzles. This oil may be sprayed either through a single or through twin nozzles. With the single-nozzle arrangement, usually the fuel is sprayed toward the throat of the chamber, so that the relatively thick stream of oil can be broken up by air forced into the chamber by the advancing piston. In other designs, as shown in Fig. 3, two nozzles spray streams of oil from opposite sides of the chamber. These mix in the center and are given a further turbulent motion by the air entering at the throat. In this design the shape of the edge of the throat has a considerable influence on the mixing and combustion. If the edge is rounded, the oil and air fail to mix completely, and combustion is imperfect and delayed.

To some it is a matter of surprise that this design will function satisfactorily with a compression pressure as low as 350 lb., while the plain cylinder design requires, as does the air-injection Diesel, a compression of close to 500 lb. The difference is due to the variation in volume-to-surface ratios. With the plain cylinder cavity, the clearance volume, as the piston nears the end of its stroke, becomes quite pancake in effect, and the large amount of water-cooled surface rapidly cools the hot compressed air. With the design shown in Fig. 1 *B*, the surface per unit volume of the combustion chamber is not so great, and the cooling is less marked. In addition, the shape is such that there exists at the center of the chamber, and remote from the cold walls, a core of hot air, which insures ignition of the fuel.

The precombustion chamber principle was early taken up by engine designers. The first commercial application was on the Brons, or, as it is known in this country, the Hvid engine. Here a predetermined charge of fuel was admitted into a cup communicating with the working cylinder through a small drilled hole. During the com-

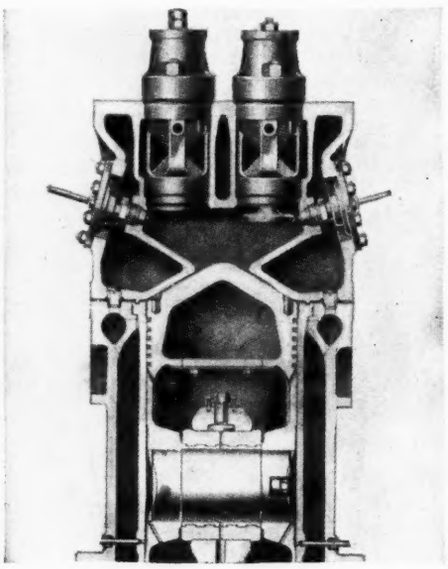


Fig. 3—Type of combustion chamber in De La Verne engine

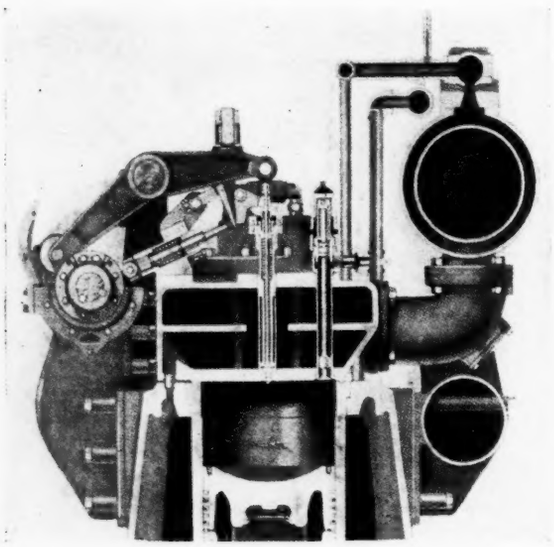


Fig. 2—Cylinder of the Bessemer four-stroke-cycle Diesel using direct spraying

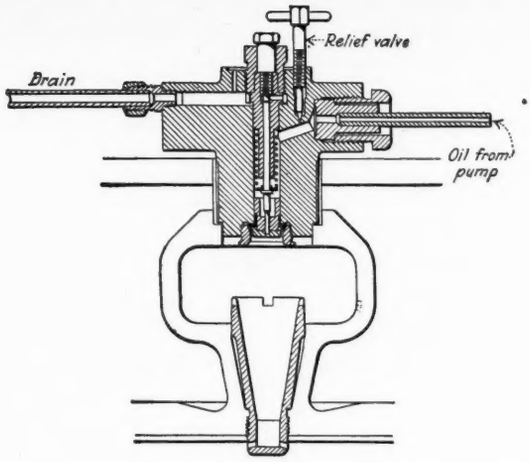


Fig. 4—Precombustion chamber on a Chicago Pneumatic Tool Company four-stroke-cycle Diesel

pression stroke, hot air blowing into the cup through this opening united with a small part of the fuel, resulting in an explosion in the cup. The resulting pressure forced the remainder of the charge through the hole into the working cylinder, where the main part of the combustion occurred. Many Hvid four-stroke-cycle engines are still being built.

In Fig. 4 is shown the design of a precombustion chamber used on a present-day four-stroke-cycle Diesel. The orifice, or throat, is of venturi form, to give a high velocity to the stream flowing from the chamber, as it reaches the orifice openings. No great effort is made to obtain a fine spray formation as the oil enters the precombustion chamber.

One of the earliest designs of the device applied to two-stroke-cycle Diesels is shown in Fig. 5. This chamber was but partly water-cooled, and the hot surface was to some extent depended upon to insure ignition.

The precombustion principle has been generally adopted for vertical two-stroke-cycle engines using crankcase compression. One of the earlier designs was the Leissner, which included a chamber in the cylinder head into which was inserted a perforated sleeve. The idea was that the sleeve induced completeness of vaporization of the fuel and at the same time, by segregation, prevented high precombustion pressures. Under field, or service, conditions, it has been found that absence of the sleeve has no detrimental effect upon the engine's behavior. In fact, one builder used a diaphragm, or flat partition, instead of the sleeve and claimed that results were dependent upon the partition. However, erectors found that the engine would develop its load easier without the partition, and many of the engines were so altered before the builder became aware of the fact.

As used generally, the precombustion chamber is a plain hemispherical cap carrying the fuel nozzle, and fitting over a small cavity in the cylinder head. The lower part of the chamber may have a reversible lining carrying the orifice, or a separate orifice plate may be used. As a high degree of atomization is not needed, the oil is ejected in a comparatively coarse stream.

It has been claimed by various designers and engine builders that the entire fuel charge actually vaporized in the pre-combustion chamber, so that only oil vapor entered the cylinders. This assumed condition is far from the actual. Tests on a hot-bulb engine show that the temperature of the bulb never exceeded 600 deg. F. at the time of fuel ignition. Tests by Wollers and Ehmoke show that the ignition point of an oil gas is much higher than that of the oil itself. For example, the ignition point of oil vapor produced from a fuel oil is from 1,150 to 1,200 deg. F., while the oil itself will ignite at a temperature of 620 deg. F. Evidently, in the hot-bulb engine an oil vapor would not ignite, due to the low-bulb temperature, but the oil would burn direct. This condition must apply to the high-pressure precombustion engine in which the compression temperature, especially at starting, is not over 1,000 deg. F.

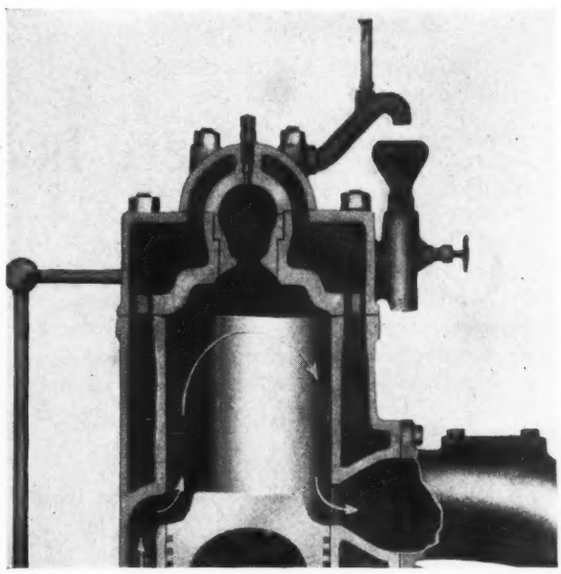


Fig. 6—Fairbanks, Morse & Company's two-stroke-cycle Diesel using a precombustion chamber

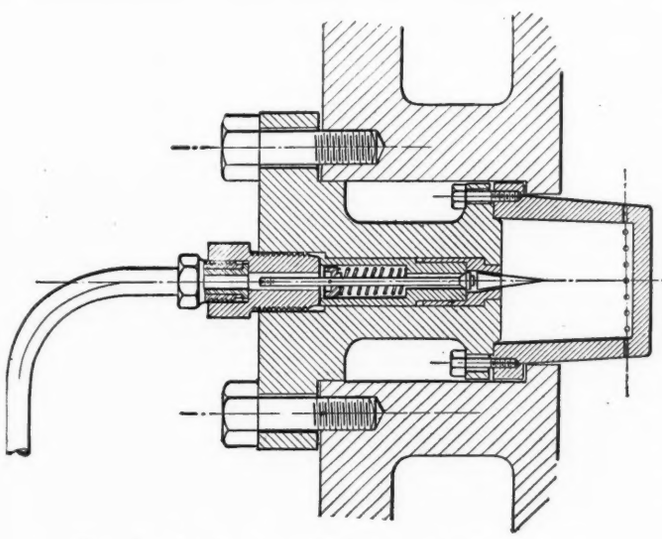
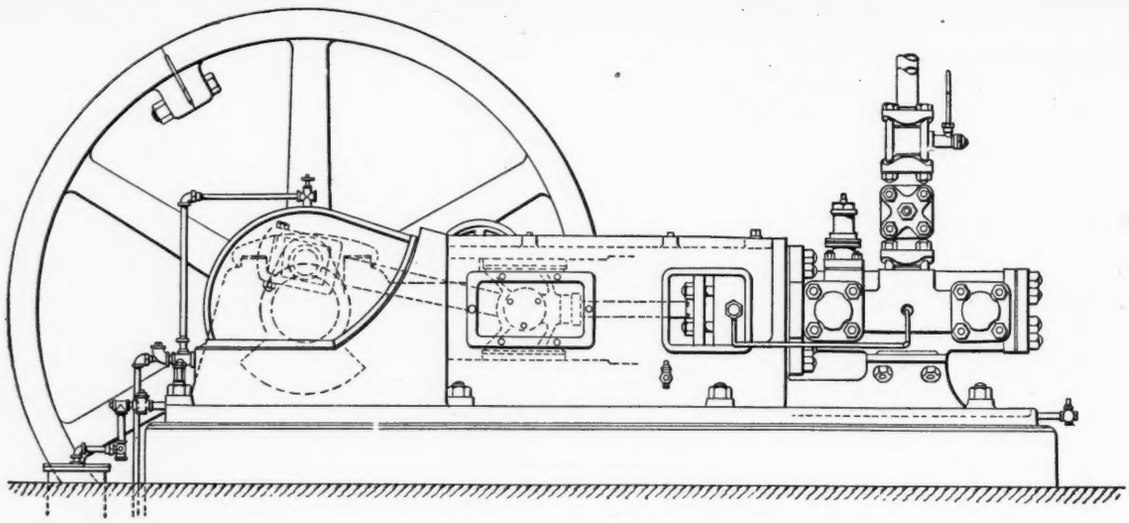


Fig. 5—Early precombustion chamber of the Nordberg two-stroke-cycle engine

While there are hundreds of combustion arrangements, the three shown in Fig. 1 may be said to embrace all designs used with solid-injection Diesels. The fuel consumptions per brake-horsepower of engines using any of the three principles are practically identical, but the arrangement shown in Fig. 1 *A* permits the development of the most power per stroke volume, that of Fig. 1 *B* is next, while Fig. 1 *C* permits a capacity about half that of Fig. 1 *A*.



There Is No *Mystery* in CO_2 Refrigerating Systems

By Gerald Grow

MANY engineers well versed in the handling of ammonia refrigerating machines are the least bit abashed when placed in charge of a CO_2 system. The difficulties to be expected are few, and operation procedure is quite simple. This I will attempt to show.

The stuffing box of the open-type CO_2 compressor requires special consideration, but no more than the ammonia machine, especially in view of the fact that the CO_2 type is usually run on the "wet-compression" cycle.

The expansion valve should always be regulated to a point where the suction line frosts clear up to the compressor. This not only keeps the piston rod cool, but also holds the discharge temperature to a low value. For example, in the chart shown, the pressure, total heat and temperature for any stated condition are given. If the CO_2 evaporates in the coils at 300 lb. pressure and reaches the compressor in a dry-saturated condition, that is, with no liquid present, each pound will contain 100 B.t.u. and have a temperature of 0 deg. F. Compression would be approximately along the line marked "adiabatic compression" until the discharge pressure of, say, 1,000 lb. is reached. It will be found from the chart that the temperature of the gas will be about 145 deg. F. If the suction vapor had been superheated to, say, 20 deg. F., adiabatic compression would have raised the final temperature to 170 deg. F. Consequently, the engineer familiar with ammonia-compressor conditions should not be worried if the CO_2 discharge temperature is as low as 130 to 145 deg. F.

The lubrication of the compressor entails no unusual attention, nor any special grade of oil. If the system is to work under low-suction temperatures, as is the case in certain industrial applications, an oil of a low pour test should be ordered. This will prevent the paraffine wax from settling out and clogging the oil lines.

It is a little more difficult to separate the oil from the liquid CO_2, for the densities of ammonia and oil do not agree so closely as do the density of CO_2 and oil. It is, then, advisable to remove the oil while the carbon dioxide is in a gaseous state. Therefore, the separator should be placed in the discharge line as near as possible to the compressor. This position does not require a separator of large dimensions, for the gas volume per pound is low. The discharge temperature of carbon dioxide is much below the vaporizing point of oil.

The discharge, or condenser, pressure should be such that it corresponds to a temperature about 10 deg. F. above the temperature of the water leaving the condenser.

If the pressure rises above this value, one can be certain that air has entered the system and should be purged out. Carbon-dioxide gas is much heavier than air. Since the air collects in the top of the condenser, the purge valve should be located there. While the air is being eliminated the pressure drops to its correct value, but a small amount of carbon dioxide may be lost. It is well to close the purge as soon as frost collects on the purge valve, which shows that the carbon dioxide is expanding through the valve and cooling the pipe to below the frost point.

Carbon dioxide, unlike ammonia, does not decompose. The CO_2 system is already above atmosphere, quite different from the ammonia system (when working at low evaporating temperature), with the suction pressure close to atmospheric.

The amount of condenser water needed per ton is

more than in case of ammonia, for the reason that the work of compression per ton of actual refrigeration is greater. The curves in Fig. 2 give the total heat to be removed per ton of refrigeration. The weight of water for any set of conditions can be determined if the desired water temperature rise is established.

As with ammonia, too much of a charge of CO_2 will cause the head pressure to rise, simply because the liquid fills part of the condenser, making the volume available for the gas less. Due, however, to the small difference between the weight per cubic foot of CO_2 gas and liquid, the head pressure will not rise so markedly as with ammonia. Too small a charge will lower the head pressure somewhat, but it is first noticed through the defrosting at the expansion valve. Gas instead of liquid will be entering the coils.

Leaks at joints can be detected in several ways. The addition of peppermint oil is one method. Its odor will announce that CO_2 is leaking somewhere. But the exact point of leak cannot be detected in that way. Soapsuds can be brushed along the joints, and the escaping CO_2 will cause the formation of a mass of bubbles. Another method of detection is to pass a bottle of ammonia along the joint. The leaking CO_2 will unite with ammonia to form ammonium carbonate, which is a white gas.

To introduce a charge of CO_2 attach the drum to a connection to the low-pressure side; the connection is usually at the compressor. Run the compressor in the usual way until the drum has frosted up, indicating that its pressure is that of the suction line. Let the drum rest until it thaws out. Then continue to empty it. If the system is kept free from joint leaks the amount of recharging needed is no more than in case of an ammonia system. Leaks are not so noticeable and the first sign is a drop in head pressure.

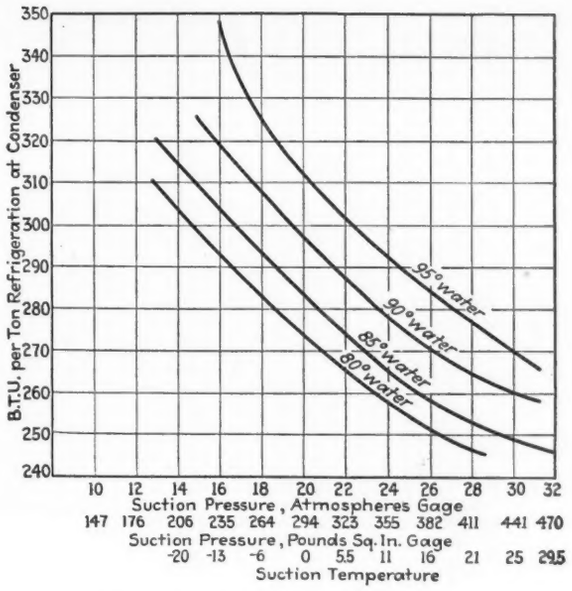


Fig. 2—Condensing water needed

To start a compressor: Turn on the water to the condenser. Follow this by opening the compressor discharge globe valve. Now start the compressor, and open the suction globe valve slowly. If the compressor pounds, liquid CO_2 is entering, and the suction valve should be partly closed. The machine started, the engineer should open the expansion valves until the suction pressure reaches the desired point. To stop the machine, close the suction valve and stop the compressor; then close the discharge valve and shut the water off the condenser and close the expansion valves.

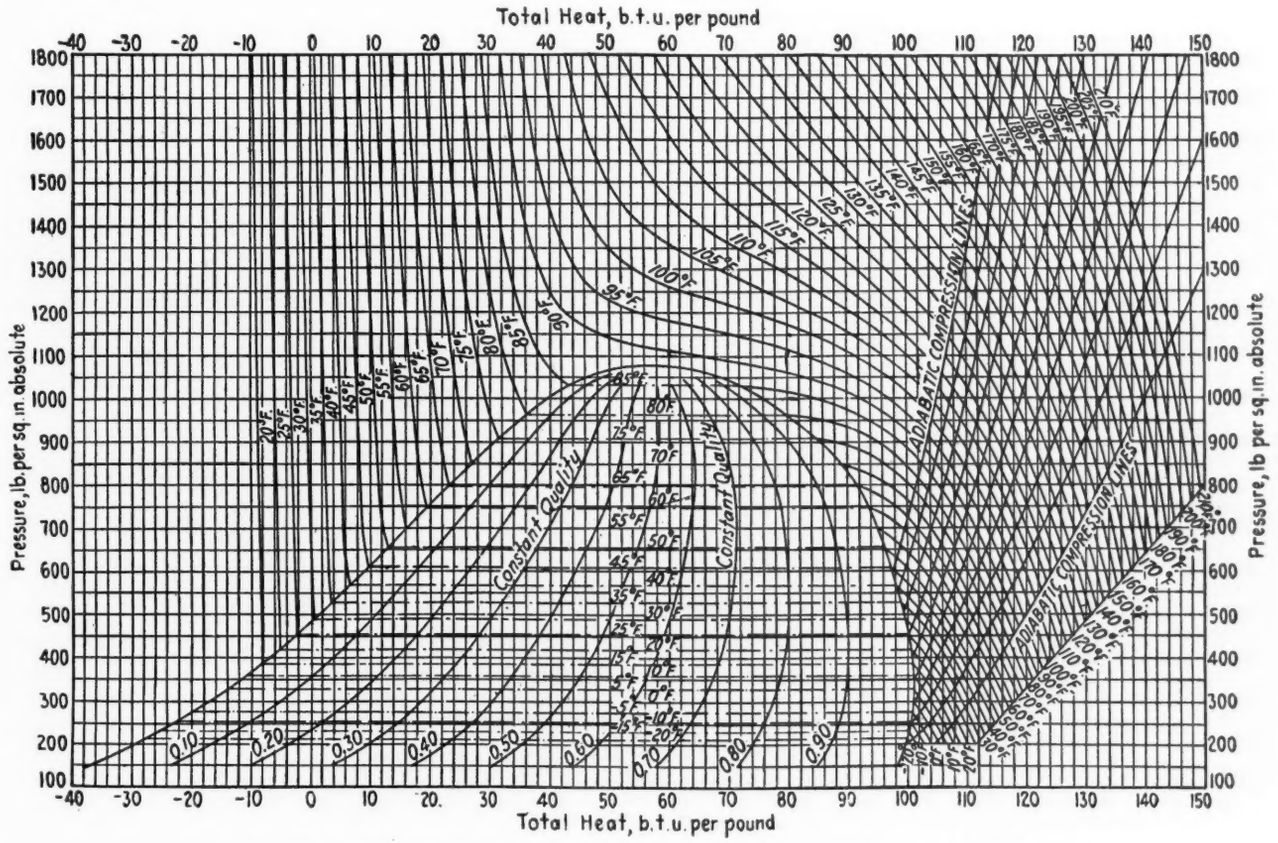
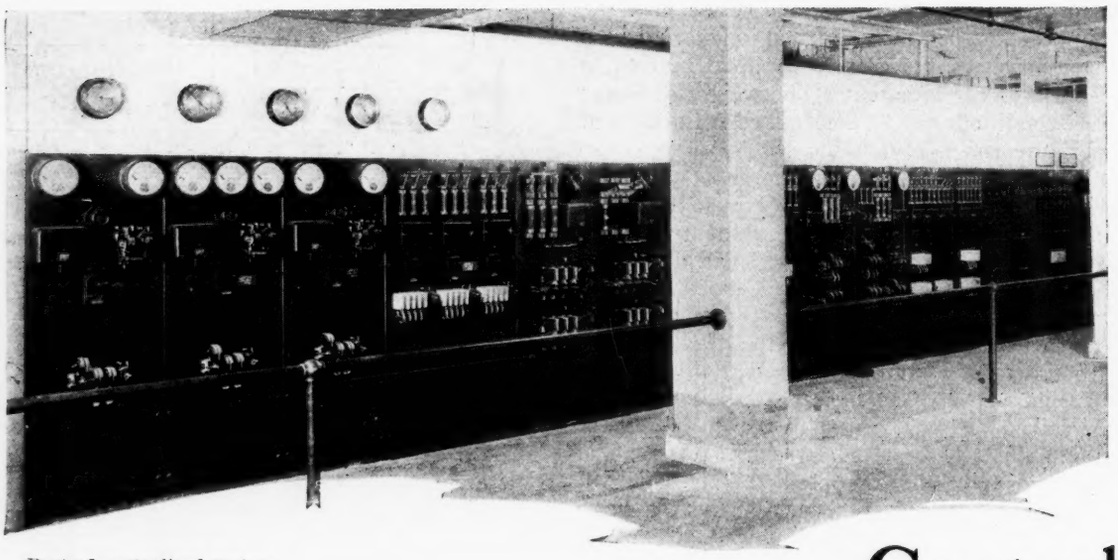


Fig. 1—Heat diagram for carbon dioxide by which the cycle may be followed

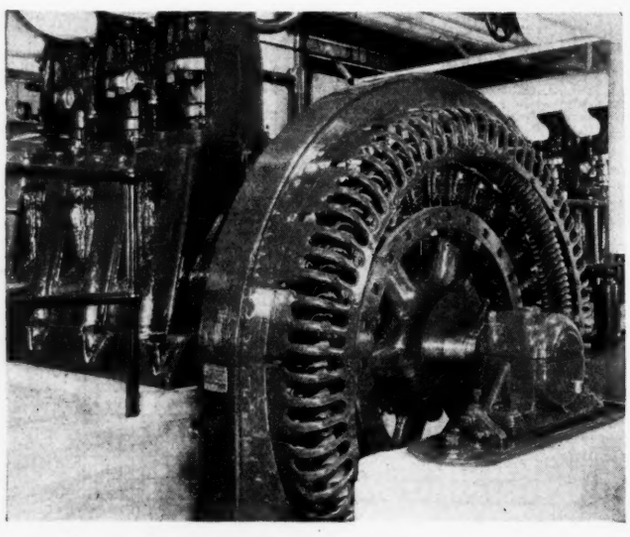


Part of centralized motor-control panels in Union Trust Building

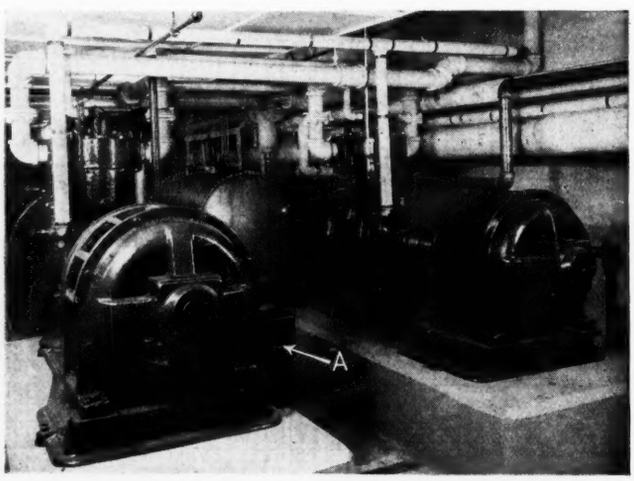
Centralized *for* OFFICE BUILDING

THE Penobscot and Union Trust office buildings are two of the newest and largest in Detroit. Each incorporates many features for convenience of operation and comfort of tenants. In each building most of the machinery is located in the third basement. To control the motors driving this equipment centralized panel boards have been arranged. These control boards were built especially for their respective places, and on them are mounted all the push buttons, instruments, magnetic switches, relays, disconnecting switches, pressure governors, vacuum switches, and fuses necessary to operate and properly protect the motors. There is some motor-driven machinery on upper floors, and where it is desirable to control it from the basement, push buttons and tryout switches and indicating lights are mounted on the control boards.

The boards are made of ebony asbestos an inch thick. There is a busbar on the back of each board at the top. This busbar feeds a row of fused disconnecting switches from which the motor current goes through thermal overload relays to starting and running contactors and from there to the motors. All devices are accessible, easily inspected and maintained. The panels were simple to erect because they included the necessary framework and were all wired. It was only necessary to stand them on the sills, fasten the braces, attach a feeder to the one busbar and then connect the panels to their proper motors.

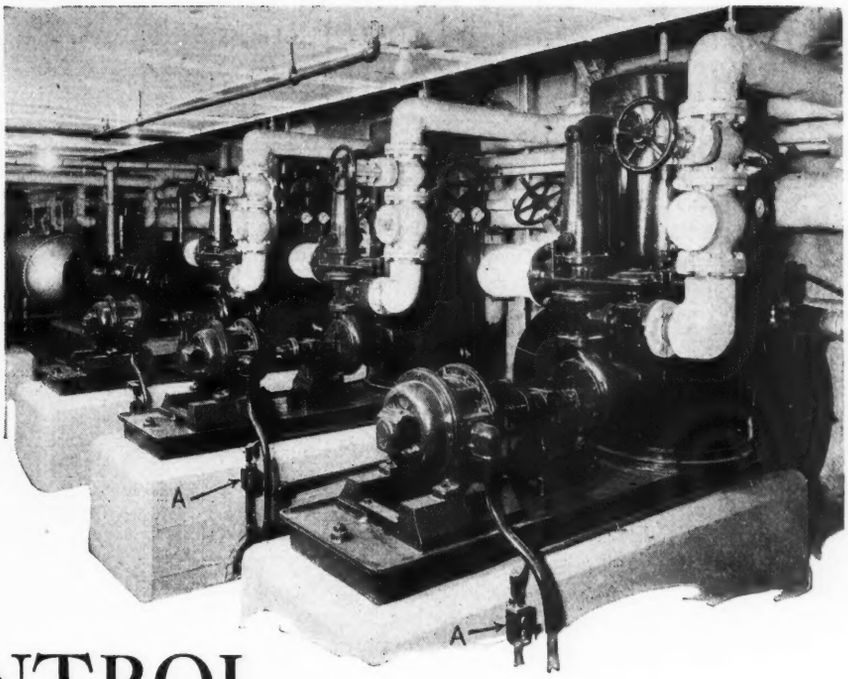


Three 300-hp. 4,600-volt synchronous motors drive CO_2 compressors



Air compressors are driven by 75-hp. 1,800-r.p.m. 440-volt induction motors. Note control push button at A

A start-and-stop control station is also fastened inconspicuously to each machine. This not only makes it possible to control each from its location, but it also makes for safety. An operator can stop a machine quickly if necessary, and then by means of a locking bar can be sure that no other person can start the machine from the main board.



Vacuum pumps driven by 7½-hp., 1,800-r.p.m., 440-volt motors. Push-button control stations at *A*.

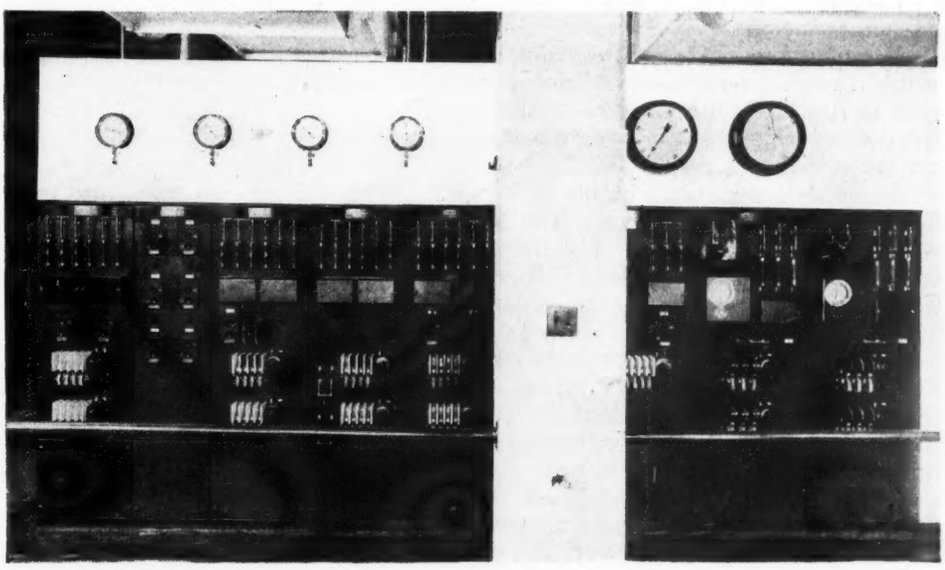
By A. A. SHIRLEY
General Electric Company
Detroit, Mich.

Panels MOTOR CONTROL

In the Union Trust Building are three 300-hp. 4,600-volt synchronous motors driving refrigerating compressors. It is desirable to keep the high voltage isolated, so the main switches are mounted remotely in a locked room; but all the instruments, relays and contactors are on the main board. Push buttons control these motors the same as the small ones. The panels for controlling the synchronous motors are the three on the left in the picture at the top of the left-hand page.

Some machines, such as vacuum pumps, house pumps and air compressors, are governed automatically by vacuum switches, pressure governors and float switches. To make it possible for the operator to have full control, tryout switches allow him to start and stop the motors without regard to the positions of the automatic devices. The control also governs fans, air filters, ozonerators, sump pumps, hot-water circulating pumps, drinking-water pumps, compressors and other service equipment.

The appearance of the boards is pleasing. The machinery room is free from scattered starters and disconnecting switches mounted on pipes and walls near the machinery in an unsightly, crowded manner. The cost of a board of this kind is about 50 per cent more than standard starters for the same service, but the construction work is less, due to the lack of necessity of mounting the starters disconnecting switches, and other equipment and connecting them together. In any building or machine room using a considerable number of motors, a centralized control board is warranted. The entire cost is not of great consequence when compared to the cost of the rest of the equipment. The owners of the Penobscot Building, and the architects, Smith, Hinchman & Grylls, initiated the idea in an effort to get the controls of the motors on the different building services where the operating engineers can conveniently see them operate and know their condition easily.



The panels on the right and those at the top of the first page constitute the centralized motor-control board in the Union Trust Building. The panels on this page are for the control of 440-volt induction motors driving air compressors, vacuum and other pumps. At the top of the first page the first three panels on the left are for the control of the 300-hp. 4,600-volt synchronous motors

Heating System Maintenance in the Equitable Building Follows Routine Schedule

ROUTINE inspection and maintenance, and complete operating records form a partnership necessary to the best operation of any plant. Without records the effect and need of maintenance work are easily overlooked, and without maintenance a good plant soon loses its efficiency. The advantage of this partnership is recognized by the superintendent of the Equitable Life Assurance Building, New York City, and maintenance and records are made to co-operate in keeping the heating and ventilating equipment of this building always in good operating condition.

The heating system is a two-pipe Webster vacuum, with up and down feed. Steam generated in six oil-fired boilers is led through a sixteen-inch main to the fifteenth floor, where it is distributed by a header running close to the walls of the building. From this header up and down feeders carry the steam to the radiators.

The amount of direct radiation is equivalent to about 82,000 sq.ft., and consumes an average of about 38 million pounds of steam a year.

Ventilation has been provided for three basements, and the second, third, fourth and fifth floors, serving a volume of about 4,687,000 cu.ft. Air for the supply is brought from the roof on the third floor through air washers and tempering coils and delivered by supply fans to the various ventilated rooms. For this purpose seventeen air washers and supply fans having a total capacity of 642,800 cu.ft. per minute are regularly in operation. The capacity of the exhaust fans for this system is 582,740 cu.ft. per minute. At the air washers heating stacks having a total effective heating surface of 33,604 sq.ft. heat the air during the winter months to the desired temperature.

The ventilating system uses an average of 17,000,000 lb. of steam a year, 900,000 cu.ft. of water and about 700,000 kilowatt-hours.

But little maintenance work is done during the winter months. It consists largely of adjustments to the thermostat regulators, repairing leaks and tending to emergencies as they arise. About 70 per cent of this work is done between 9 p.m. and 5 a.m., while the heating system is shut down.

Notations are made on the daily logs of the maintenance work done on the various equipment. In addition to this, notes are made regarding work that should be done during the summer, when the equipment is more available.

Real maintenance work begins in the spring, when the heating system is shut down. The boiler room is the scene of the first activity. The boilers are drained of water and the drums opened. They are cleaned thoroughly and made ready for inspection. The furnaces are cleaned and such repair work as necessary is done on the brickwork. When this has been finished, the boiler dampers are closed and about 25 lb. of unslaked lime is placed in the bottom of the furnace. The purpose of the lime is to absorb whatever atmospheric moisture finds its way into the boiler.

As soon as the regular insurance and city inspection has been made, the boiler drums are coated with graphite, closed up and filled with water, as experience indicates that less corrosion occurs when the boilers are full of water than when allowed to stand empty. They are then ready for operation next fall.

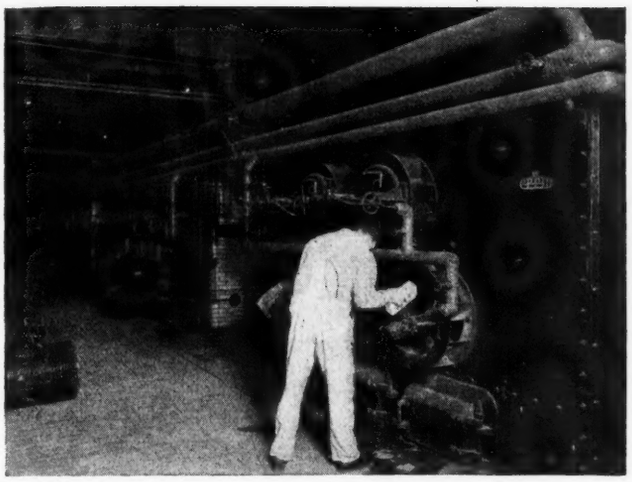
Attention is next turned to vacuum pumps. The condensate receiver tanks are drained, cleaned and given a coat of graphite. The pump casing is removed and the impeller examined and cleaned. The bearings are inspected and cleaned and the old oil replaced. The shaft packing is removed and left out until the pumps are ready to go in operation at the start of the next season. This is done because the packing if left during the summer becomes hard and dry. Similar attention is given to all of the other water service pumps necessary for the building's operation.

Next, all of the main valves in the heating system are inspected and the old valve-stem packing removed, even though it may appear to be in good condition. New packing is placed around the valve stems and the valves made ready for use in the fall.

All of this work is carried on by the regular boiler room and pump room crews. By working industriously

OPERATING COST DATA

Steam Cost:	1926	1927	1928
Gallons of fuel oil used	747,707	640,440	642,995
Pounds of fuel oil used	5,981,656	5,123,520	5,143,960
Pounds of water evaporated	75,654,566	67,914,620	68,568,785
Average evap. per pound of oil	12.95	13.25	13.33
Fuel oil, cost per gal.	$0.045–10 mo. .05 – 2 mo.	$0.05	$0.05–10 mo. 0.038–2 mo.
Total cost of oil for year	$35,596.94	$32,022.00	$30,247.72
Total cost for labor for year	14,092.00	14,092.00	13,764.00
Total cost of steam (including maintenance)	$49,688.94	$46,114.00	$44,011.72
Cost of steam per 1,000 lb	$0.66	$0.68	$0.63
Steam Consumption, Lb.:			
Direct heating	38,025,000	35,496,950	37,469,480
Indirect heating 3, 4, 5 floors	7,691,200	7,542,920	6,034,100
Indirect heating, basements	11,645,680	10,585,810	10,287,680
Vestibule, 31st St.	1,927,985	1,640,540	1,758,145
Vestibule, 32nd St.	2,316,375	1,410,190	2,219,820
Hot water-basement	9,667,910	5,869,420	5,457,330
Hot water, 15th floor	2,069,084	1,911,740	1,758,810
Restaurant	2,295,210	3,445,390	3,571,700
	75,638,444	67,902,960	68,557,065
Steam unaccounted for	16,122	11,660	11,720
Total pounds of steam consumed	75,654,566	67,914,620	68,568,785
Cubic Feet of Water Consumed:			
Air washers	551,596	921,505	1,327,776
Boiler make-up water	186,544	206,918	263,809
Filters	222,106	419,835	504,030
Hot water	623,900	604,100	416,870
Restaurant	306,906	396,995	454,959
Store	167,989	236,702	345,461
Toilet rooms, barber shop, Photostat rooms, slop sinks, Laboratories	3,797,442	3,976,137	3,404,203
Total	5,856,483	6,762,192	6,717,108
Electric Energy Kw.-Hr.:			
High rise elevators	431,889	418,513	436,794
Low-rise elevators	167,600	147,910	137,650
Vacuum pumps	16,340	13,590	11,500
Sump pit pumps	18,050	24,170	25,190
Fuel oil pumps	18,119	17,424	13,192
House pumps	82,690	97,230	118,160
Boiler feed pumps	66,920	57,090	69,070
Air compressors	40,360	47,270	53,200
Tube machine	63,046	65,100	68,350
Supply fans	391,946	410,583	447,122
Exhaust fans	263,140	323,142	320,068
Motors not metered	149,600	135,678	86,210
Total kw.-hr.—power	1,709,700	1,757,700	1,786,506
Total kw.-hr.—light	1,620,800	1,688,600	1,686,400
Total kw.-hr. consumed	3,330,500	3,446,300	3,472,906
Cost of Running Ventilating System:			
Repairs	$267.33	$232.20	$14.25
Maintenance	1,820.00	1,820.00	1,820.00
Cleaning	806.00	662.00	778.00
Steam	11,615.14	9,426.94	10,282.72
Water	551.60	921.71	1,327.78
Electric current	18,293.33	19,878.79	22,081.32
	$33,353.40	$32,941.64	$36,304.07
Cost of direct heating	$27,892.77	$26,212.42	$26,111.89



The boiler room in the Equitable Building. Furnace repairs are being made on the first boiler

during the summer, they are able to finish the necessary maintenance and overhauling work before the heating system starts in the fall.

While the work in the boiler room is going on, all of the radiator and return-line traps are inspected. The traps are taken apart and cleaned and the operating mechanism is dipped in oil. If the seats or disks are pitted, they are ground or replaced. Dipping the trap parts in oil prevents rusting during the summer months, while the valves are not in use, and has been found to reduce the trap bills by 75 per cent. During the past five years only twelve traps have had to be replaced. This work is delegated to one man who, in addition, operates the ventilating fans and cleans all of the air washers once a week. During the winter he does what is necessary to keep the thermostatic system in proper operating condition.

The article "Meters Reduce Operating Cost in Office Buildings," published in the Sept. 17 issue of *Power*, described the metering equipment and operating records maintained by the superintendent of the Equitable Assurance Society Building. This article indicated how the metering equipment was used not only to supply records from which efficiency figures could be compiled, but also as a guide for maintenance work, which itself has resulted in considerable savings.

The results obtained through the metering equipment, the operating records maintained and the well-planned maintenance schedules are shown in the table of operating and maintenance cost data. These data are compiled for the years 1926, 1927 and 1928, and a comparison shows how little steam costs and consumption of steam, water and electricity varies from year to year.

Utilization of Powdered Fuel Dates Back a Hundred Years

A RECENT report of the Market Research Institute of the National Coal Association, compiled by H. W. Brooks and other experts, reveals some interesting facts regarding powdered coal in American industry. The record of the earliest utilization of coal as fuel remains lost in the annals of antiquity. There are numerous references to its use found in the literature of ancient and medieval times. However, within the lifetime of the present generation more has been learned in the field of combustion technology than in all preceding ages.

It was not until after the beginning of the nineteenth century that any attempt of which we have record was made to utilize mechanical stokers in the combustion of coal. Curiously enough this first attempt, initiated by Niepce in 1809, contemplated firing coal as powdered fuel. This experiment proved unsuccessful, but pulverized fuel was not forgotten. In 1831 an English patent was granted to "John Samuel Dawes, Ironmaster of Bromford in the Country of Stafford," wherein puddling furnaces were fired with powdered coal. In this same year Henschel in Germany employed powdered coal in heating brick kilns, in soldering and in many other furnace applications. Shortly after, Putsch in England endeavored to apply it to glass manufacture. Subsequent metallurgical pulverized fuel patents were granted in England in 1846, 1854 and 1856.

Shortly after the American Civil War there was a renaissance of interest in powdered coal both in England and America. Whelpley and Storer in 1866 took out an American patent for firing powdered or granulated coal as an auxiliary fuel over a grate-fired furnace. It was ignited by the fire on the grate and burned in the air coming up through the burning solid fuel bed. Incidentally, this practice is still followed in several installations in Holland and Germany and has recently been proposed as a *new* development in America! Crampton in England, between 1866 and 1867, succeeded in burning coarsely pulverized coal in both puddling furnaces and boilers, and even at that early day claimed evaporations of 10 to 11 lb. of steam per pound of coal with smokeless stack emission—a phenomenon hitherto unknown.

In 1867 and 1868 Chief Engineer (Admiral) B. F. Isherwood, U.S.N., carried out tests at the Boston Navy Yard in the hope of firing marine boilers with powdered coal, but these attempts proved unsuccessful.

In 1895 Messrs. Hurry and Seaman, at the works of the Atlas Portland Cement Company, proved so conclusively that powdered fuel could be used as effectively, and much more economically than fuel oil for cement kilns, that within a decade more cement was fired with coal than with oil. Within twenty years 75 per cent of all cement manufactured was thus fired.

There were many other unsuccessful and partially successful efforts to apply the ever-fascinating idea of a finely divided fuel burned in suspension and thus approaching complete gastification. Among the more interesting of such efforts were those of Bettington, a South African consulting engineer, who in 1906 invented and shortly after installed, a powdered coal-fired boiler with water-cooled walls, utilizing air preheaters and unit pulverizers. In 1903 the Lebanon, Pa., plant of the American Iron & Steel Company (now Bethlehem Steel Corporation) commenced the experimental use of powdered coal in metallurgical furnaces, eventually installing over 100 furnaces of various types, such as for puddling, heating, reheating, etc.

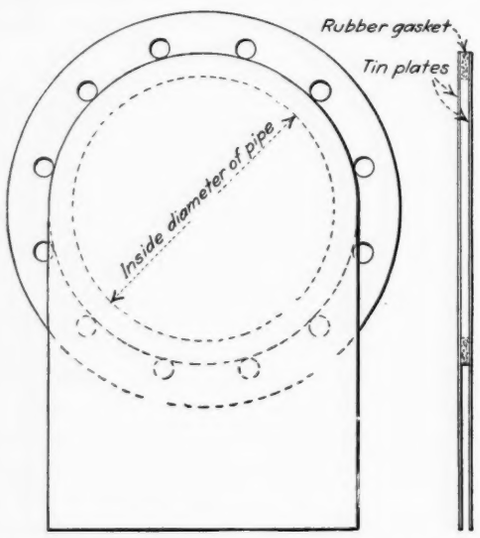
Unquestionably the beginning of the commercial success of powdered coal for boiler firing dates from the year 1919 with the plants of the Milwaukee Electric Railway & Light Company, and the Puget Sound Light & Power Company. Particularly, in the former of these two plants, was learned for the first time the possibilities of over-all steam generating efficiencies in the neighborhood of 90 per cent.

Right Out of the Plant

An Easy Way of Placing Soft Rubber Gaskets in Big Pipes

RECENTLY we had to change several pieces of 14-in. water line and renew some gaskets on the same line during a limited time. Everything went well until we wanted to put in the new rubber gaskets.

As the space between the flanges was small, we had difficulty in getting the soft gaskets into place, until one



Gasket is held between two thin metal plates and inserted between flanges

of the pipefitters suggested that we cut two tin plates (any thin sheet might be used) of the shape shown in the sketch.

We put the gaskets between the two sheets and found it very easy to place the whole thing between the flanges. The sheets were taken out one at a time without affecting the position of the rubber joint. ADOLF VON EUW.

La Plata, Argentina.

Pointers on Balancing Pulleys

IT IS customary for the average engineer when in need of a pulley to call up the supply house and order it. When the pulley arrives it is placed on the line shaft with little or no thought as to the balancing of it. He just takes it for granted that the pulley is "all right." But I have seen several cases where they were "all wrong."

Before any pulley is installed it should be checked to determine if it has been properly balanced. This is one practical point that engineers in general have overlooked, but it deserves careful attention. An unbalanced pulley is hard on belts. If every pulley in the plant were unbalanced there would be a variation in speed with every revolution of the pulley.

Upon investigation of this subject I was surprised to learn the number of engineers who do not know just how to go about balancing a pulley. One of the easiest ways is to place the pulley on an arbor centered in a lathe. Give the pulley a spin and mark the side that turns down. Now place putty on the opposite side—or on two spots 120 deg. apart—until the pulley balances, or will stop in any position. Then weight the putty and cut pieces of steel of equal weight and rivet them to the inside of the rim.

Balancing ways are better than the lathe, particularly for large pulleys. These are made by fastening narrow rigid strips of metal on the top of two sawhorses, placing them so that the arbor will rest on each and leveling strips with a spirit level. This method produces little or no friction, and a well-balanced pulley can be attained.

Los Angeles, Calif. W. D. CAMPBELL.

Determination of Total Alkalinity Aids Feed-Water Treatment

THE most important use of the knowledge of the salts making up the total alkalinity in boiler feed water is in maintaining the proper alkalinity—sulphate ratio—to inhibit caustic embrittlement. Although the mechanism of this process is still under discussion, present practice dictates the maintenance of a minimum ratio depending on the boiler pressure. Since this value is the ratio of total alkalinity, expressed as sodium carbonate, to sodium sulphate, a knowledge of the quantities of various carbonates, bicarbonates and hydrates is essential to convert them into terms of sodium carbonate.

In actual practice, it is usually customary to express the carbonate (CO_3), bicarbonate (HCO_3) and hydrate (OH) as calcium carbonate ($CaCO_3$), together with the calcium (Ca) and magnesium (Mg) ions, also as $CaCO_3$ by means of the following conversion factors:

CO_3 p.p.m. $\times$ 1.667 = carbonate alkalinity expressed as $CaCO_3$ p.p.m.

HCO_3 p.p.m. $\times$ 0.819 = bicarbonate alkalinity expressed as $CaCO_3$ p.p.m.

OH p.p.m. $\times$ 2.941 = hydroxyl alkalinity expressed as $CaCO_3$ p.p.m.

Ca p.p.m. $\times$ 2.497 = calcium hardness expressed as $CaCO_3$ p.p.m.

Mg p.p.m. $\times$ 4.115 = magnesium hardness expressed as $CaCO_3$ p.p.m.

Total alkalinity expressed as $CaCO_3$ $\times$ 1.06 equals alkalinity expressed as Na_2CO_3 p.p.m.

Sulphate ion (SO_4) $\times$ 1.479 equals sodium sulphate (Na_2SO_4) p.p.m.

In addition, a knowledge of the total alkalinity of boiler water will indicate to the plant engineer whether his water treatment is removing all the scale-forming salts, just what scale may be expected, and the concentration of soluble salts in the boiler feed, an excess of which is conducive to foaming and priming.

In the case of raw water, this information is especially valuable in determining the quantities of chemicals necessary to render the water harmless, and to prescribe treatment and processess. To the feed-water expert, this knowledge will indicate many other important and interesting facts, but to the plant engineer with a probable limited chemical training such information is best used as outlined above. S. E. TRAY.

Jackson, Mich.

Why the Voltage Varied on the Exciter

SOME time ago a 10-kw., 125-volt exciter, which had been belt-driven, was direct connected to an alternating-current motor which had just been rewound by an outside repair shop.

The exciter was taken apart, cleaned and painted, the connections were cleaned and tightened and new bearings were installed. The motor to which it was to be direct connected operated at a speed 300 r.p.m. faster than the exciter, so holes were drilled in the main field poles to compensate for the increased speed.

When the unit was put into service it ran satisfactorily, at times. And again the exciter voltage would vary from one-half to full voltage. It was so sensitive at times that walking on the suspended platform seemed to start the voltage varying.

Every known test was applied to the exciter, but it appeared to be in good operating condition. Finally it was suspected that something was wrong with the driving motor instead of the exciter. The repair company which had rewound the motor was notified, and a man was put on the job immediately. He again checked over the exciter and the motor winding without finding any cause for the trouble. He then put an ammeter in the motor circuit, and this soon indicated that the cause of the trouble was in the motor. An inspection of the motor rotor revealed several loose bars. When these had been repaired by welding the unit operated perfectly.

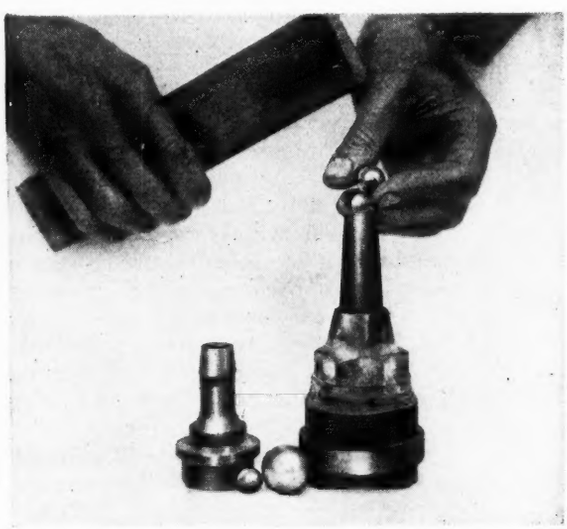
Niagara Falls, N. Y. MARIN PHILLIPS.

Straightening Up Small Nozzle Ends

SMALL light brass nozzles are often accidently dropped or struck and a portion of the end dented in, leaving the opening out of round. With special tools or a jig it is, of course, possible to swage them out and into shape again, but too often nothing can be immediately found to answer the purpose. If you happen to have a collection of odd-size ball bearings, try the method illustrated.

Take a ball slightly larger in diameter than that of the nozzle orifice and tap it down in the nozzle lightly with a block of wood. If the bruised portion of the nozzle is not too deep, the ball will force this portion of the metal out into a true circle again without unduly enlarging the opening. A smaller ball can be used first if the crushed portion extends some distance into the nozzle. This is a neat and practical way to repair small nozzles. F. W. BENTLEY, JR.

Missouri Valley, Iowa.



Ball bearings are used to remove dents in small nozzles

Draining Vacuum and Compressor Lines

WITH reference to the article in the Oct. 8 number of *Power* entitled "Draining Vacuum and Compressor Lines," the method of draining lines shown in the illustration is, in my opinion, bad practice, as it does not insure the equipment against slugs of water. Furthermore, it would tend to give the engineer and his assistants a lot of unnecessary work; as well as make it much more difficult to explain to the management why traps should be installed to do the work that is now being done by the engineers. I consider an improvised device of this kind useless, for in most cases it would take but a short time for the receiver to fill up, and since effective operation depends wholly on the human element it is likely to fail when most needed.

In the second paragraph, Mr. Roger says, "where the necessary expenditure cannot be made for traps, a small receiver as illustrated will prove satisfactory." The necessary expenditure can be made, and would be made, if the conditions and probable results were properly explained or presented to the management; for no management is going to take a chance of damaging or wrecking any equipment costing thousands of dollars, for the price of a vacuum trap. J. A. SCHAFFNER.

Hudson, Mass.

Testing the Cleanliness of Knife Switches

THE cleanliness of the blades and contacts of a switch or the contacts of a circuit breaker can be checked by a drop test. Perfect contact between the movable and fixed contacts is often prevented by a thin film of oxide and dirt on them. This cannot be seen by the naked eye, but nevertheless causes the contacts to heat. The apparatus needed is a millivoltmeter, two lengths of flexible wire terminating in contact points and two insulated handles.

The test is made when current is flowing, the two contacts being held on the two switch terminals. The deflection on the millivoltmeter will show the voltage drop across the switch. In the case of a perfectly clean switch the voltage drop should not exceed ten millivolts, and can be even lower.

In one instance a larger circuit breaker was tested in this way before cleaning. The voltage drop was 100 millivolts. Cleaning reduced it to 10 millivolts. In another instance a switch after cleaning showed a voltage drop of only 6 millivolts. This drop is largely caused by the film of oxide which quickly forms on the copper surfaces. It increases the resistance and the heating of a switch.

The best way to remove this film, in the case of an ordinary knife switch, is to cut off the current, give the blades a thin coat of vaseline and work the blade in and out several times. Then wipe both the blades and the contacts clean, and work the switch as before.

In the case of circuit breakers both the fixed and mov-

able contacts should be kept clean and bedding together perfectly. The best way to clean copper contacts is with a paste made of fine pumice powder and machine oil. It is not good practice to use emery paper for this work, as the hard emery grit is liable to get embedded in the soft copper surfaces; also emery is a conductor of electricity. Finally, clean away every trace of the cleaning paste. W. E. WARNER.

Brentford, England.

Spring Wedges for Leveling Machinery

THE letter entitled "Spring Wedges for Leveling Machinery," which appeared in a recent number of *Power*, interested me. It seems to me that it is a matter of preference as to whether the wedges should be driven, or placed, after the machine, or engine, as the case may be, has been raised by a pinch bar or by some other means.

In past years I have had considerable to do with the building and erecting of steam engines. I have never had any real difficulty with the use of wedges for leveling a bed, and the wedges were driven in with a hammer to raise the bed to the desired place. Of course, much depends upon the taper of the wedges used as to whether the position of the bed will be changed. If thin and comparatively long wedges are used, with parallel packing pieces to build up with, it is not likely the bed will shift as claimed. The use of a pinch bar under certain conditions would tend to move the bed out of place more readily than would a wedge. I have seen marine engine bedplates accurately lined up with little else than slim tapered steel wedges, and they were driven in with hammers. CHARLES J. MASON.

Brooklyn, N. Y.

Passing Steam Through a Reducing Valve

THE answer to a question in the Oct. 8 issue of *Power* that after passing a reducing valve steam has its original heat content is true for the steam issuing from the reducing valve. There is something else to be considered if we are going to avail ourselves of the superheat contained in the steam at the outlet side of the valve.

In general practice, steam from a reducing valve is conveyed some distance to the point where it is used for heating or process work, and a greater part of the superheat is lost before it can be used.

The writer witnessed a test of a triple-expansion engine conducted by three prominent mechanical engineers. The steam pressure was 180 lb. abs., and the supply pipe was 150 ft. in length, well-covered with 85 per cent magnesia 1½ in. thick. The thermometer at the outlet from the boiler gave 50 deg. F superheat, but the thermometer at the throttle of the engine gave a temperature corresponding to the pressure. In this case all trace of superheat had disappeared.

A test was made of a set of drying cans in a cotton mill employing steam at 5 lb. gage, obtained by reducing from 80 lb. through a reducing valve. All trace of superheat was lost in a travel of 10 ft. through an uncovered pipe. Of course the use of an uncovered pipe was bad practice; however, in heating problems we must depend upon uninsulated surfaces.

Engineers have noticed a greater consumption of fuel in cold weather, when, due to brief periods of curtailment of production, the engine was not in operation and the steam used for heating was drawn through a reducing valve instead of from the exhaust of the engine. In part this may be accounted for by the loss of the frictional heat generated by the machinery when operating.

When necessary to operate machinery for process work with the balance of the plant shut down and the power obtained from water or purchased, steam being furnished through a reducing valve, a greater consumption of fuel has occurred than when the exhaust from an engine was used.

We cannot get something for nothing; but in the case of the reducing valve we are assuming we get all, or nearly all, of the heat that was in the steam at the inlet side of the valve for our use, when actually we only get a small part, in numerous cases not any, of the superheat.

Lowell, Mass. T. N. KELSEY.

[The question and answer did not deal with the heat content obtainable at a distance from the reducing valve, but merely with the conditions immediately at the valve. —L. H. M.]

Molds for Hydraulic Leathers

IN the Aug. 27 number of *Power* W. F. Schaphorst criticizes my article on "Molds for Hydraulic Leathers," which appeared in the July 11 number. He agrees with me that it is better to use the flesh side of the leather as the working surface, but thinks that leathers made as I make them to be inferior to factory-made leathers. He also considers my molds antiquated, and he may be right—although the factory-made article may sometimes be unworthy of the specialist.

No sensible engineer will attempt to make what he can better buy, but no sensible engineer will allow a shutdown of his plant if he can avoid it by making something that will prevent it. To know how to make hydraulic leathers may be worth a great deal more than to know where to buy them in an emergency. For the engineer is often so situated that he has to depend upon what he can do, as well as on what he can buy.

Personally, I want to know how to make good hydraulic leathers and I shall be glad if Mr. Schaphorst or anyone else will tell me how I can improve on my present methods as outlined in the article referred to.

Abergavenny, England. E. J. JORDAN.

Cause of Commutator Blackening

IN THE August 13 number of *Power* various reasons are given for the blackening of the commutator on a direct current generator. I had the same trouble some time ago, in a small generator carrying both lighting and motor load. I tried different ways of setting the brushes, resurfaced the commutator, adjusted the air gap, and, finally, checked the meters to make sure there was no overload. This, however, did not eliminate the trouble. The first time the machine could be shut down for a few hours, we scraped out the mica insulation from between the bars to a depth of $\frac{1}{64}$ inch.

When this had been done the machine operated perfectly for nearly four months under full load, then the old trouble reappeared, but it was soon corrected by clearing the carbon from between the bars as before

It would appear that the brushes give off more carbon at full load, and that the particles lodge between the bars and stick there, they being slightly oily owing to the brushes having been treated in boiling oil.

Ahmedabad, India. M. M. VYAS, *Chief Engineer*, The Maneklal Harilal Mills.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

New Recording Pyrometer Has Wide Chart and Open Record Scale

TO the line of temperature measuring apparatus put out by Wilson Maeulen Company, Inc., 383 Concord Ave., New York, has been added the model No. 8201 potentiometer recording pyrometer illustrated.

Important features of the new instrument are the use of an unusually wide chart with an open record scale and a simplified mechanical movement. The chart is 12 in. wide overall, with 11 in. of calibrated scale, and the openness of the scale permits more accurate determinations of the readings.

The instrument operates on the potentiometer principle. When the measured voltage from the thermocouple changes as a result of temperature changes at the thermocouple, the galvanometer pointer deflects in the corresponding direction. At intervals of 10 seconds a boom descends and grips the pointer firmly, while two sensing fingers, moving in a vertical plane, approach the pointer from each side, exploring for the location of the pointer, and if either finger finds the pointer deflected and away from its central, or null, position, a roller ratchet dog is released by the finger, causing a drum to turn.

By means of a violin string wound around the drum and passing over pulleys at each side of the chart, and attached at opposite sides of a carriage, the motion of the drum in either direction is transmitted to the carriage, which is adapted to travel back and forth across the whole instrument.

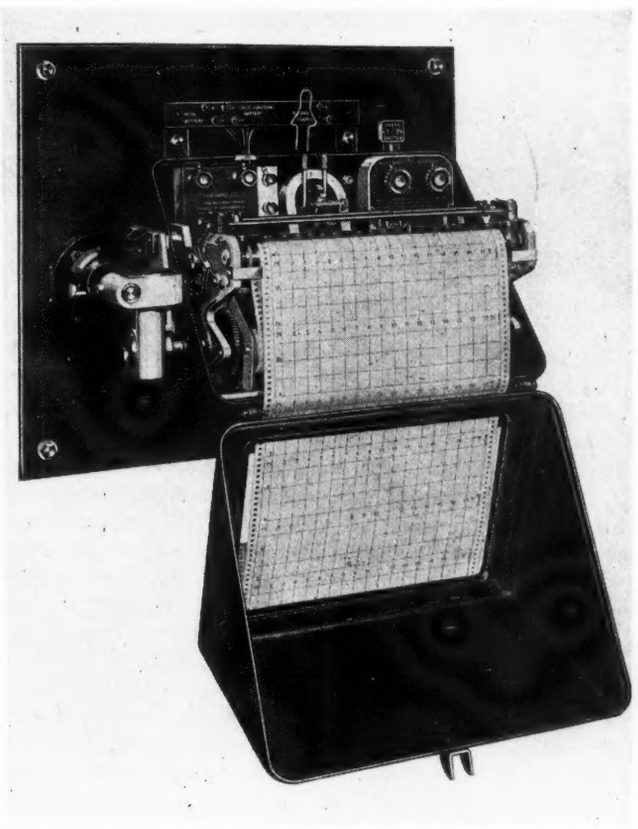
The selective operation of the drum's rotation, both in direction and extent, moves the contact on the slide wire so as to bring the galvanometer back toward its null, or undeflected, position, and at the same time moves the pen to record on the chart the temperature of the thermocouple.

A choice of three chart speeds, namely $\frac{3}{4}$ in. per hour, $1\frac{1}{2}$ in. per hour and 3 in. per hour, permits the user to secure the speed most suitable to his needs. On operations where temperature changes are slow and long periods of time are involved, the slow speed condenses the record and makes observation of trends and cycles easier. For rapidly fluctuating temperatures and short cycles of operation, the faster speeds allow more detailed analysis of temperature changes. The recording pen and the slide wire contact are integral and cannot get out of relationship with each other. The recording pen has a metal tube siphon and an ink reservoir that holds a supply of ink sufficient for record roll. The ink used with the instrument has a brilliant red color and dries quickly on the record before the chart emerges from the case.

Changes in the temperature of the thermocouple cold junction are automatically compensated for in the instrument by an electric cold-junction compensator, similar to the automatic compensators used on other types of pyrometers put out by this company.

An external drive unit, suitable for either 110 volts or 220 volts alternating current is employed. It consists of a motor with double worm and gear speed-reducing system, located outside the instrument case. The unit provides ample power for operating more than one instrument, and the design is arranged so that a group of recorders, or a group combining this recorder and an automatic temperature control pyrometer, can be operated by one drive unit.

Charts are available for a wide selection of scale ranges, in both Fahrenheit and Centigrade, to suit the various types of thermocouples and the various temperatures of industrial operations. For low temperatures, from 600 deg. F. down to 0 deg. F. or lower, this same recorder is supplied to operate as an electric thermometer employing resistance bulbs. The instrument case opens diagonally, making the entire mechanism readily accessible.



Potentiometer pyrometer recorder with cover open

Leather Belt Designed for Short-Center Drives

SHORT-CENTER belt drives are used extensively in mechanical power transmission. These drives have been developed in two forms.

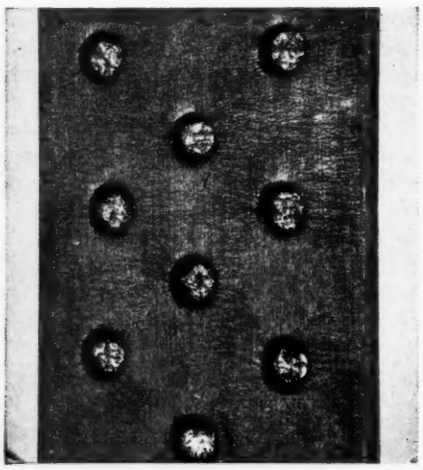


Fig. 1—Perforations in inside ply of the belt

One uses standard belts and an idler, the latter to increase the belt's arc of contact with the small pulley, thus providing the necessary friction to allow the belt to drive its load. The other type of short-center belt is specially constructed to have a high coefficient of friction and does not require an idler pulley. A belt of the latter type has recently been placed on the market under the trade name Tak-Hold by the Slip-Not Belting Corporation, Kingsport, Tenn.

It is of the flat-leather type, designed to run on standard pulleys located on short centers, usually without idlers or tightness of any kind. In construction, the belt consists of an outside ply of the company's Slip-Not leather and an inner ply that is perforated as shown in Fig. 1. The two plys are cemented together onto a specially designed center which serves as a cushion and muffler. It is claimed that the perforations cause a suction grip on the pulleys, and that this feature combined with the high coefficient of friction peculiar to the leather produces the take-hold qualities.

One of the applications of this belt is on the company's Uni-Pull drive, Fig. 2. With this drive, proper tension is maintained in the belt at all times by supporting the motor so that part of its weight is taken by the belt. The combination belt and drive is intended to work on applications usually thought of as requiring chains, V-belts or gears.

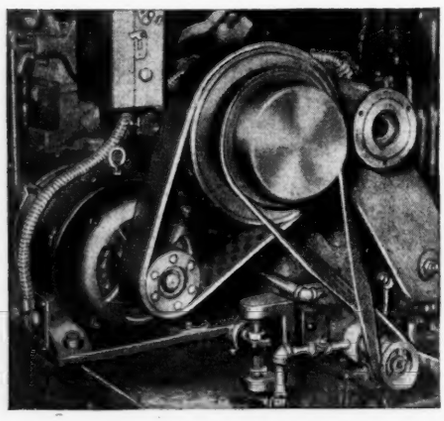


Fig. 2—Belt applied to Uni-Pull drive

Circulating Pump for Hot-Water Heating Systems and Other Services

TO PROVIDE a positive circulation in hot water heating systems and thereby increase materially the efficiency of the complete system, H. A. Thrush & Company, Peru, Ind., has introduced the vertical motor-driven pumping unit, or circulator, illustrated.

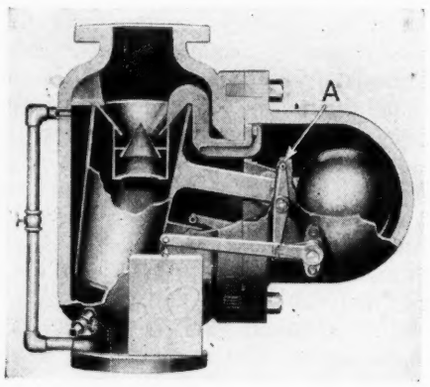
Vertical motor-driven circulator

The pump is installed on the return line at a point near the boiler, and provides a definite circulation through the boiler, thereby increasing the amount of heat absorbed by the water per unit of fuel used. It is available with either a 110- or 220-volt motor and in 2- and 3-in. pipe sizes, having capacities of 30 and 70 gal. a minute, respectively. This is sufficient to supply 2,500 and 6,000 sq.ft. of radiation.

Quick-Closing and Water-Stop Throttle Valve

THE quick-closing and water-stop throttle valve illustrated is designed to protect engines, turbines and pumps against damage from slugs of water coming over with the steam. It is placed on the vertical steam line to the unit above the throttle valve.

Referring to the illustration, a bucket is held in an upward position



Valve is designed for automatic operation and remote control

against a stop by a counterweight supported on two knife edges. Steam entering the valve is directed into the bucket by cone-shaped baffles. These baffles cause the steam to change its direction, and in this way any entrained water is thrown to the bottom of the bucket. Under normal operation any small amount of condensation is drained from the bucket through two or more holes drilled at the bottom above the valve seat. In the event of sufficient water coming over to cause damage to the prime mover, the weight of the water passing into the bucket will overbalance the counterweight and cause the bucket to descend and close the bottom outlet, thus stopping the flow of steam temporarily until the line is drained of condensation.

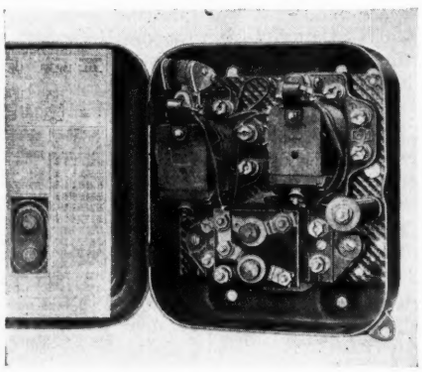
Provision is made in the design of the valve for remote control of the closing operation. A counterweighted lever and latch are provided on the outside of the valve, the latch holding the lever and weight in the upward position until the latch is released. The releasing operation can be performed either manually, mechanically or electrically. This external lever and latch mechanism does not in any way interfere with the valve's closing automatically as a result of slugs of water coming over with the steam.

The valve is put out by the Morton Vacuum Breaker Company, Canton, Mass.

Across-the-Line Starter for Direct-Current Motors

SMALL size, double-line break, thermal overload protection, low-voltage protection and silver contacts are some of the important features incorporated in the automatic, across-the-line starter, for general applications of direct-current motors up to 2 hp., 115 or 230 volts, announced by Cutler-Hammer, Inc., 190 12th St., Milwaukee, Wis. Two magnetic contactors, one in each side of the line, connect the motor directly across the line on starting and provide a double-line break. The contactors are designed especially for direct-current service and have renewable silver contacts.

The thermal overload relays are the same as those used in the across-the-line starters for small alternating-current motors put out by the company. They are the fusible alloy type and can be adapted to any size motor by simply changing the heater coils. When tripped by an overload,



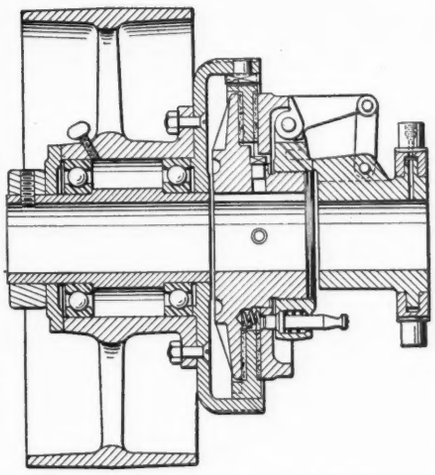
Starter with cover open

the relays are reset by pushing a button in the cover.

Each starter is furnished with a push button master switch, three-wire control. This master switch can be furnished mounted in the cover of the starter, or it can be arranged for mounting separately. The starter with push buttons in the cover is illustrated. These starters are also made without the thermal overload relays, for applications where overload protection is not required.

Twin-Disk Clutch With Ball Bearing Pulley

HERETOFORE one of the principal objections to the use of a loose pulley has been the difficulty in keeping it sufficiently lubricated when



Section of clutch and pulley

idle to avoid excessive wear on the shaft. This objection has been largely overcome through refinements in design and the adoption of anti-friction bearings in the pulley. Various improvements have also been made in friction clutches, important among these being the adoption of friction surfaces similar to those used in the automotive industry.

The illustration shows a friction clutch mechanism put out by the Twin Disk Clutch Company, Racine, Wis., and distributed by the Chicago Pulley & Shafting Company, 17-23 Desplaines St., Chicago, Ill.

The clutch and pulley are mounted on the shaft as a unit, with the clutch body keyed to the shaft and the pulley free to turn on the ball bearing when the clutch is not engaged. A housing is attached to the pulley hub, and carries a friction plate fitted with Raybestos lining.

Adjustments of friction are made by screwing the toggle collar inward. This collar is held in place by a large pin which when it is withdrawn and the collar is rotated snaps into one of twelve holes in the loose plate.

"Rustless" Chrome-Iron Alloys

A SERIES of four brands of rustless iron, known as "Defirust," "Special Defirust," "Defistain" and "Defiheat," are being manufactured by the Rustless Iron Corporation of America, 122 East 42d St., New York, N. Y. The four brands are chromium-carbon alloys, and, as their trade names indicate, are manufactured for corrosion resistance, all of them containing a high percentage of chromium and a very small amount of carbon.

Two-Stage Oxygen Regulator

A TWO-STAGE oxygen regulator, designed to eliminate fluctuation in working oxygen pressures has been added to the line of welding equipment put out by the Oxweld Acetylene Company, 30 East 42nd St., New York City. This regulator, which is designated the type R-109, incorporates stem-type valves, which have been used in the single-stage regulators.

The chief feature of the improved design is two-stage pressure reduction, accomplished by two independent sets of diaphragms and valves. Instead of reducing the full cylinder pressure, of about 2,000 lb., down to working pressure, which is often only a few pounds, in one stage, the new regulator reduces through this wide range in two stages. In the first stage the cylinder pressure is reduced through a non-adjustable reducing valve to about 175 lb. Leaving the first stage the oxygen passes to a second valve and diaphragm assembly, where the pressure is reduced to that desired by the operator, the second-stage reducing valve being adjustable by a hand wheel.

When the pressure in the cylinder falls below about 175 lb. the first-stage valve remains fully open. It is thus automatically cut out of the system and the second-stage valve and diaphragm only are operative. The new regulator, it is claimed, will operate with equal efficiency whether the oxygen cylinder is full or nearly empty, and the working pressure will

Type R-109 oxygen regulator

remain constant. The R-109 regulator is intended to supersede type R-105.

FROM AMONG READERS' PROBLEMS

Conducted by
L. H. MORRISON

RELATION OF STACK HEIGHT TO DIAMETER—*What relation has the height of a stack to its diameter?*

T. K.

The area of the chimney to handle a given weight of flue gases depends upon the velocity of the gases, for, obviously, the volume of gases passing per second is equal to the area of the stack times the gas velocity, multiplied by a coefficient to cover losses.

A much-used formula is $A = \frac{W}{12\sqrt{L}}$

when A = cross-sectional area of stack, W = weight of coal burned and L = stack height.

The height L depends upon the draft pressure at the base of the stack P_d, the atmosphere pressure P_a, the inside air temperature T_a and the gas temperature T_g. These factors may be combined into a formula

$$L = \frac{P_d}{0.52\, P_a\left(\frac{1}{T_a + 460} - \frac{1}{T_g + 460}\right)}$$

Where L is in feet, P_a in pounds per square inch, P_d is in inches of water and T_a and T_d are in deg. F.

BOILER VIBRATION INDUCED BY RECIPROCATING ENGINE—*In our plant we have two 72-in. x 18-ft. horizontal tubular boilers in brick settings. We have installed a 150-hp. four-valve engine, and for some reason the pipe line shakes violently. The boiler shakes so much I am afraid the brick setting will fall. What is the trouble?* M. T. W.

Evidently the speed of the engine is such that the vibration set up by the reversal of the forces acting on the piston is in harmony with the natural period of vibration of the boiler and piping. About the only way to correct this is to raise or lower the engine speed a few r.p.m.; or the addition of an ample steam receiver ahead of the throttle might help.

BLEEDING FROM A CONDENSING TURBINE—*We have a 1,000-kw. condensing turbine. We wish to bleed at 25 lb. from an opening now in the turbine casing at a point when the turbine pressure in this amount. Is this a safe procedure?* E. E. S.

Condensing turbines have been tapped for bleeding steam. You should find no physical interference, but the efficiency of the turbine will be decreased, due both to the withdrawal of the steam and to the fact that to carry the same load as before a greater amount of steam would have to be fed through the throttle.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

A REVOLVING dryer of the Yankee paper machine type used in drying paper is supplied with saturated steam generated at 125 lb. gage. The steam has a quality of 98 per cent.

Will a pressure of 45 lb. within the dryer bring about a greater heat exchange and dry more paper than if a 25-lb. pressure were carried?

L. M. P.

WHEN steam at 125 lb. is expanded to 45 lb. or 25 lb. in the dryers, it immediately comes in contact with water of condensation, thereby losing any superheat it may carry, and, consequently, the steam temperature will be the saturated temperature corresponding to the pressure.

At 45 lb., therefore, there would be a higher temperature difference between the inner and outer dryer surfaces, and a higher rate of heat exchange, than at 25 pounds.

The quantity of paper dried per hour, or, more accurately, the amount of water evaporated, would be greater at 45 lb. than at 25 pounds.

Since the rate of heat transfer depends only on the quantity of steam condensed, circulation of steam through the drier would be of no benefit except as a means of carrying away air that might be mixed with the steam supply or present in the dryer at the beginning of operation. W. G. MACNAUGHTON.

New York City.

I WOULD say that there are a number of variables that enter into the problem, such as the presence of air and water in the cylinder, freeness of the stock, moisture in the sheets, as well as thickness of the sheets and ventilation of the machines, all of which must be taken into consideration.

Rankine's formula assumes that the heat conductivity through the walls of a cylinder is directly proportional to the difference in temperature between the two faces of the metal. If we assume that a temperature of about 100 deg. exists on the outside of the drum in contact with the paper, then some 2,900 more B.t.u. per hour per square foot of dryer area would be transmitted through the iron from the 45-lb. steam than from the 25-lb. steam. It is, of course, problematical what this outside temperature is, chiefly because of some of the variables already mentioned.

From tests which we have made, we know that paper of all grades can be dried satisfactorily, if the evacuation equipment is proper, in quantities far beyond the limits of what the wet end of the machine can supply, with far less pressure in the dryer than assumed for as minimum in the question. In fact, machines of the highest speed are being run with not enough pressure to stir the needle of the gage.

No trap system can possibly free the dryers from air, and with buckets, such as are assumed instead of syphons, the water will not be fully removed, unless there is a free circulation of steam out of the dryer to assist its movement. It is the aim of all workable systems of dryer drainage to approach direct blowing of steam through the dryers, without wastage of steam from the final end of the dryer section. The passage of heat from steam to a wet plate is much accelerated by impingement of the steam on the plate. Therefore, we feel that blowing steam through the dryers as far as we can allow it, will assist in the heat transfer to the wet paper on the outside of the dryer.

ROLAND PAGE,
The Fulton, Engineering Co.
Middleton, Ohio.

SATURATED steam at 25 lb. gage has a temperature of 267 deg. Steam reduced from a pressure of 125 lb. 98 per cent dry to 25 lb. will have a slight superheat, of about 11 deg. F., but this extra temperature is immediately lost when heat is given up to the dryer shell, and does not affect the performance appreciably. If steam is used in the dryer at 45 lb. gage, the saturated temperature at this pressure will be 292.5 deg., and the drying capacity of the machine will be increased. The amount of the increase has sometimes been figured as proportional to the differences between the steam temperatures and 100 deg. On this basis, for 25-lb. steam, 267 — 100 = 167, and for 45-lb.

steam, 292.5 — 100 = 192.5. The increase by using the 45-lb. steam is 15 per cent. The exact amount of the increase for a particular machine, however, can be determined only by trial.

An injector system is sometimes installed, with the idea of creating a rapid circulation of steam inside the dryer and thereby increasing the heat transfer through the shell. However, a little consideration of the area of cross-section of the steam space and the amount of steam used in the dryer, will show that the velocity of steam over the dryer surface is rather low at best. The greatest resistance to heat flow is at the outside surface of the dryer rather than at the steam side, or, in other words, the steam is capable of imparting heat to the shell as fast as the shell can give it up to the drying paper at the outside. On the steam side, however, the effectiveness of heat transfer is governed greatly by the amount of air and non-condensable gases present. These gases lower the temperature of steam in the dryer. The prompt removal of air is of greatest importance in obtaining maximum capacity from a paper machine or any other steam heating apparatus.

G. B. LONGCOY.

Lakewood, Ohio.

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IN PASSING steam through a reducing valve, where no external work is done, the steam will be superheated or its moisture content will be evaporated. In either event no heat will be lost. The 125-lb. steam of 98 per cent quality when reduced to 45 lb. gage will still be slightly wet, so there will be no superheat, for the expansion will simply reduce the moisture content. The temperature will be that of 45 lb. saturated steam, or 292.7 deg. F.

The heat content of 25-lb. saturated steam is 1,169.4 B.t.u., and its temperature is 267.3 deg. F. Calculations show that when reduced to 25 lb. gage, the steam will be superheated 4.1 deg., giving a total temperature of 271.4 deg. F.

As the heat exchange is dependent on temperature, the 45 lb. steam has the higher temperature and should be used.

To obtain maximum efficiency, the dryer should be kept free of water. To effect this it is necessary to remove the condensate as rapidly as it forms. Any system that will keep the dryer water free will increase the heat transfer. Drying performance is dependent on difference in temperature between the dryer surface and the paper. If water accumulates on the bottom of the dryer it acts as an insulator and retards the heat transfer, for the conductivity of water is much lower than that of iron. It may be argued that the water in the dryer will be at the same temperature as the steam. The surface in contact with the steam will be at steam temperature; but that in contact with the dryer will be lower, for it is being constantly cooled by the wet sheet of paper.

RALPH W. B. READE,
The Flintkote Company.

New Orleans, La.

STEAM reduced from 125 lb. gage and 98 per cent quality to 40 lb. gage will have a temperature of 287 F. and will be practically 100 per cent dry. If reduced to 25 lb. gage the temperature will be 277 deg., which is a superheat of 10 deg. F.

Assuming the same speed for dryer factors, the amount of surface and the heat-transfer coefficient do not in any way affect the problem and need no further consideration. But the greater the temperature differential the greater will be the heat transfer to paper, and hence the greater the drying capacity. Under 45 lb. pressure we will have approximately a 10 deg. F. greater temperature differential between the steam and paper, and, consequently, a greater drying capacity at this pressure. It is to be noted, also, that, from practical considerations, the amount of superheat that can be used in drying is limited.

Considering the removal of the condensate, the only requisite is to get rid of it as fast as formed, and to keep the dryer clear of water. The manner of removal is immaterial as long as it is prompt and efficient. Syphons or ejectors will keep the condensate at lower level than will dippers. They are usually provided in the newer machines. The trap on the return system will function with equal effectiveness with either dippers or syphon. Whether a syphon or ejector should be substituted for dippers in the present case can best be determined by conditions. An examination of the amount of water in the dryer should give a clue to the answer.

Dayton, Ohio. R. MCCULLY.

A Question for Our Readers

WE NEED 10,000 lb. of process steam per hour at 45 lb. in a part of our mill located 1,000 ft. from the power house. Would it be more economical, considering pipe and insulation costs, to transfer it at 200 lb. or at 45 lb.?

C. P. S.

Suitable answers from readers will be paid for and published in the Dec. 10 issue.

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THE process of drying paper on any paper-machine dryer obviously consists of the evaporation of water in the sheet due to the transfer of heat from the steam within the dryer to the paper.

Several factors govern the efficient and economical drying of paper. These may vary according to the type and caliper of paper being manufactured. For example, steam pressure, air circulation past the dryer and paper speed have direct bearing and should be taken into consideration when determining a correct set of conditions for a given grade and caliper of paper.

In the problem outlined, computations made by use of the basic formula for quality show that if the initial steam at 125 lb. gage and 98 per cent quality is reduced to 45-lb. gage, the resulting mixture will be below the saturation point and the quality will still be below 100 per cent.

The computation follows:

$$Q = \frac{H - h - 0.47\ (T_2 - T_1)}{L}$$

Q = Proportion by weight of moisture in steam = 1.00 — 0.98 = 0.02.
H = Total heat in 1 lb. of steam at boiler pressure = 1,192 B.t.u.
h = Total heat in 1 lb. of steam at reduced pressure = 1,177 B.t.u.
T_2 = Temperature of steam after expanding.
T_1 = Temperature of saturated steam at reduced pressure = 293 deg. F.
L = Latent heat of steam at boiler pressure = 868 B.t.u.

Substituting these values in the equation we have

$$0.02 = \frac{1,192 - 1,177 - 0.47(T_2 - 293)}{868}$$

Solving for T_2, we obtain a temperature of 288 deg. F., which is below the temperature of saturated steam at 45-lb. gage, and indicates that the steam is wet.

Assuming the second condition, namely, a reduction in pressure to 25-lb. gage, and carrying out the same computation, we find that a resulting temperature of 279 deg. F. is obtained, thus:

$$0.02 = \frac{1,192 - 1,169 - 0.47(T_2 - 267)}{868},$$

T_2 = 279 deg. F.

Inasmuch as the temperature of saturated steam at 25-lb. gage is 267 deg. F., we have a difference between 279 deg. and 267 deg. of 12 deg. F., which appears as superheat.

One of the objects of the use of superheated steam in any system is to reduce the amount of condensation formed, and since the liberation of the latent heat of steam used for drying paper is dependent upon the cendensation of that steam, it follows that superheated steam in a paper-machine dryer is of no advantage. Further, superheated steam acts as an insulator within the dryer itself.

It seems to me that the most desirable condition would be to furnish the dryer with saturated steam and to find at what final pressure the 2 per cent of moisture in the original steam disappears. To accomplish this, we again employ the equation, making T_2 equal to T_1, and solve for h. This computation

$$0.02 = \frac{1,192 - h}{868}, \text{ or } h = 1,174.6 \text{ B.t.u.}$$

By consulting a standard steam table, we find that a pressure of approximately 53 lb. abs., or 38-lb. gage, corresponds to this total heat.

P. L. ULRICH.

Three Rivers, Mich.

Relative Economy of Pulverized Coal, Oil and Gas As Boiler Plant Fuels*

By Martin Frisch
Engineer in Charge of Development, Combustion Engineering Corporation

MOST steam plants are restricted in their choice of fuels by location or by other considerations. But some plants are so located that several fuels of the same type or even of different types become interesting as fuel possibilities. The managers of such plants have to determine which of the available fuels will be most economical to use. The answer to this question is not necessarily the name of the fuel which may be delivered at the plants at the lowest cost per heat unit. However, the analyses comparing their relative economy for steam-making are too laborious to be made often. The purpose of this paper is to present the results of such a comparison.

The ten fuels whose compositions and other properties are given in the table are typical of fuels commonly employed for steam-making and they have been used as a basis of the comparison. The influence of each of the ten fuels in the table on the performance of a certain boiler was investigated and the maximum efficiencies obtainable with furnaces and firing equipment most suitable to develop the highest efficiency possible with each fuel were determined.

To simplify the comparison, pulverized-fuel firing only was considered.

The conclusions of the investigation, which were checked against the results of comparable actual boiler tests, confirm the value of an index of boiler performance already suggested by others. This is the amount of sensible heat imparted to the products of combustion per pound passed through the boiler. The magnitude of this index depends on (1) the heat value of the fuel, (2) the weight of gas and vapor formed in the combustion of the fuel and (3) amount of heat made unavailable by incomplete combustion and the evaporation of moisture and the formation of water vapor by the burning of hydrogen in the fuel. The index evidently depends greatly upon the fuel characteristics.

The amount of heat lost by radiation at any capacity will be nearly the same for all of the fuels. If the heat balance of all the fuels be compared, the incomplete combustion will be found to increase in this order: Lignite, Illinois bituminous, Pittsburgh bituminous, Pocahontas semi-bituminous, and river anthracite. The latent heat losses due to the burning of hydrogen and the evaporation of moisture increase in the inverse order. No incomplete-combustion losses are expected when burning oil, but the latent heat losses are very high for these fuels, and may exceed 10 per cent for natural and coke-oven gas.

Maximum efficiencies obtainable with river anthracite and Texas lignite are 5 to 6 per cent lower than with Pittsburgh coal, on account of higher exit temperatures and carbon losses with the anthracite and on account of higher exit temperatures and latent heat losses with lignite at identical capacities and excess air ratios. The fact that oil and gaseous fuels can be burned with lower excess air than is the case with the solid fuels was taken into account in comparing the best efficiencies of these fuels. On this basis, mechanically atomized oil can be burned with efficiencies 2 to 2¾ per cent under those to be expected with Pittsburgh coal because of the larger heat loss. Steam atomization will have the effect of lowering the boiler-performance index of the oil and will cause higher exit temperature and draft losses at any given capacity.

Efficiencies attainable with blast-furnace gas will be 2 to 20 per cent lower than with Pittsburgh coal. Coke-oven and natural gas can be burned efficiently, but on account of latent heat losses, of over 10 per cent, the over-all efficiencies tc be expected with these fuels will run 3 to 5 per cent lower than with Pittsburgh coal.

The significance of these efficiency differences is to be found in Rig. 1, which shows the number of heat units that must be purchased in different fuels and supplied to the furnace per million B.t.u. of heat absorbed by the boiler.

The character of the fuel affects not only the number of fuel-heat units required per steam-heat unit, but also the amount of money that must be expended to burn properly each fuel. The final cost of steam will depend on the following factors, some common to all fuels and others peculiar to each fuel as shown:

Common to All Fuels

(*a*) Fixed operating and maintenance costs on boiler plant, exclusive of fuel and fan equipment.

Peculiar to Each Fuel

(*a*) Cost of fuel.

(*b*) Fixed operating and maintenance charges on fuel storage, handling, preparation and burning equipment.

(*c*) Fixed charges and operating charges on fans and draft equipment.

(*d*) Fixed charges on plant capacities reserved to provide peak requirements of the fuel and fan equipment.

Although a steam plant of a given capacity designed to burn some particular fuel or fuels might cost almost anything, depending on the design, labor and economic conditions at the time of construction, it will nevertheless be instructive to determine as accurately as possible to what extent the cost of the boiler plant and the fixed and operating and maintenance costs will depend

*Excerpts from a paper read at the National Fuels Meeting, A.S.M.E., Philadelphia, Oct. 7 to 10.

TYPICAL FUELS USED FOR STEAM MAKING

Ultimate Analysis, Per Cent by Weight

	Texas Lignite	Illinois Bituminous	Pittsburgh Bituminous	Pocahontas Coal	River Anthracite	Oil		Blast-furnace Gas	Natural Gas No. 1	Natural Gas No. 2	Coke-oven Gas
C	39.6	68.0	75.4	80.7	77.6	84.3	CO	27.6	25.6	....	15.2
H_2	3.0	4.3	4.8	4.7	2.3	12.7	H_2	0.2	7.0	....	9.7
O_2	10.0	8.3	6.1	4.5	3.6	1.0	CH_4	0.4	30.3	97.5	41.3
N_2	0.9	1.5	1.4	1.3	0.8	0.2	CO_2	12.1	16.0	....	3.0
S	0.5	1.4	1.4	1.2	0.7	0.8	O_2	0.1	0.8	....	....
Ash	10.0	10.0	8.5	5.0	14.0	....	N_2	59.6	7.3	2.5	30.8
Moisture	36.0	6.5	2.4	2.6	1.0	1.0	C_2H_4	....	5.6	....	....
							C_2H_6	....	7.4	....	....

Proximate Analysis, Per Cent by Weight

Volatile	32.0	37.0	34.5	18.2	8.2	....	....	....	....	....	....
Fixed carbon	22.0	46.5	54.6	74.2	76.8	....	....	....	....	....	....
Ash	10.0	10.0	8.5	5.0	14.0	....	....	....	....	....	....
Moisture	36.0	6.5	2.4	2.6	1.0	....	....	....	....	....	....

Other Properties

Heat value, B.t.u. per lb.	7,000	11,700	13,400	14,500	12,450	18,600		1,426	15,530	23,400	16,354
Fusing point of ash, deg. F.	2,200	2,000	2,100	2,500	2,400	....		....	....	....	....
Theoretical air required	5.21	9.04	10.14	10.77	9.63	14.12		0.82	10.3	16.8	10.86

Flue-Gas Analysis, Per Cent by Volume
(For the plant comparison)

CO_2	15.0	15.0	15.0	15.0	15.0	13.0		21.6	11.3	10.2	8.4
O_2	4.3	4.2	3.9	4.1	5.0	3.1		0.9	2.0	1.2	1.9
N_2	80.7	80.8	81.1	80.9	80.0	83.9		77.5	86.7	88.6	89.7

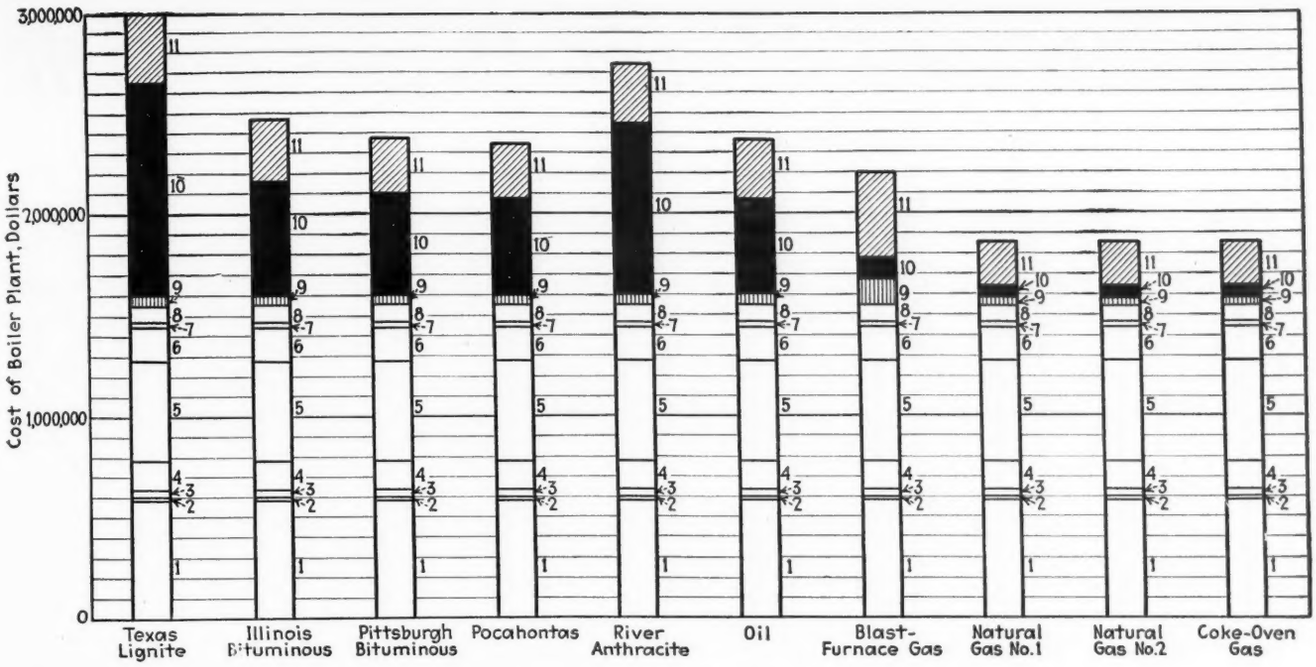


Fig. 1—Comparative cost of boiler plants utilizing various fuels

The figures indicate the total cost, installed, as follows: 1, boilers, superheaters, water walls, settings; 2, meters, instruments; 3, boiler-feed pumps; 4, stacks, breechings, insulation; 5, foundations, structure; 6, wiring; 7, site development; 8, engineeering; 9, draft equipment, fans; 10, fuel receiving, storage, handling, preparation, firing equipment; 11, reserve-plant cost for peak-load auxiliary-power requirements of boiler plant.

upon the fuel which the plant is to utilize.

The cost of building and operating steam plants best suited to meet the same annual steam-demand curve, and best suited to each of the ten fuels of the table has been calculated to make a concrete comparison of the cost of steam with the various fuels. It is assumed that 1,000,000 lb. of steam per hour is the peak capacity of each plant, and for this purpose four boilers, each capable of evaporating 350,000 lb. of steam per hour at peak load, are assumed, three boilers to carry the load and the fourth to be the spare. Air heaters and economizers are not considered, in order to keep the comparison as simple as possible.

The probable cost of such steam plants suitable to each of the ten fuels is shown in Fig. 1. The cost of the plant, exclusive of those costs affected by the fuel, is assumed the same.

All equipment and plant provisions peculiar to each fuel to be handled have been considered in computing the cost of each steam plant for the utilization of each fuel in accordance with the postulated load requirements. The fixed, operating and maintenance charges were also computed, giving the results shown in Fig. 2.

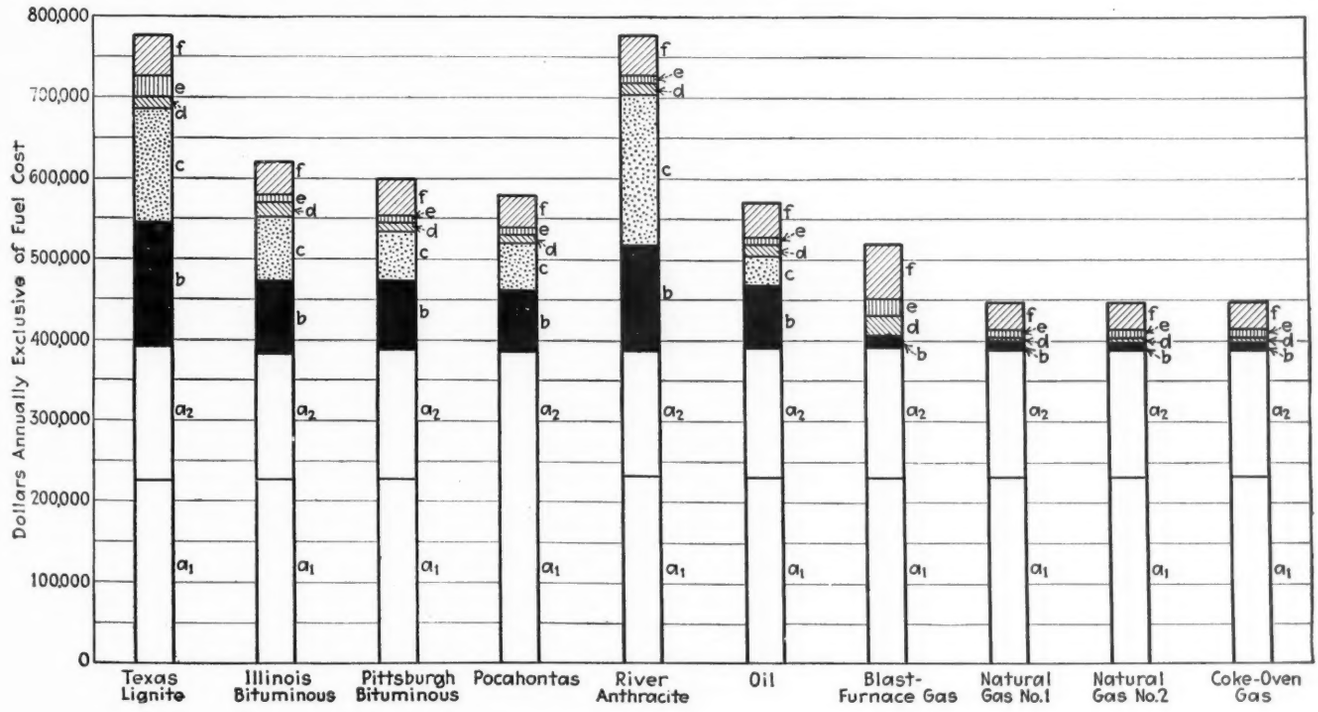


Fig. 2—Yearly cost of making steam, exclusive of fuel cost

a_1, fixed charges at 15% on boiler plant exclusive of fuel equipment [1 + 2 + 3 + 4 + 5 + 6 + 7 +8] × 0.15; *b*, fixed charges at 15% on fuel equipment and fans [9 + 10] × 0.15; *f*, fixed charges at 15% on plant capacity reserved for boiler-plant peak; *e*, fixed charges on draft equipment; a_2, operating charges on boiler plant, not including draft and fuel equipment; *c*, operating charges on fuel equipment; *d*, operating charges on draft equipment.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

*Spot * News*

PLANS *have just been announced by the Long Island Lighting Company, of New York City, for the addition of a 100,000-hp. turbine-generator, high-pressure boilers and auxiliary apparatus to its Glenwood plant, which was put into service late last year with one 25,000-hp. unit installed. It is expected the new construction will be completed during 1930.*

* * *

THIS YEAR, *due to the great amount of foreign interest in the last National Power Show, a special "Export Day" will be set aside when members of the exhibitors' foreign departments will answer questions peculiar to the exporting of various products. Numerous inquiries already received indicate a large attendance from abroad to the coming show in December.*

* * *

INSPECTION *of all hydro-electric dams in the State of Missouri has recently been ordered by Governor Henry S. Caulfield to insure public safety and prevent a repetition of the famous Johnstown flood. Stratton Shartel, attorney general, and Dr. H. A. Beuhler, state geologist, will conduct the inspection.*

* * *

ELECTRICITY *led as the cause of fatalities in the growing number of mine explosions reported for the fiscal year ended June 30, 1929, according to a recent announcement of the Bureau of Mines. Open lights and arcing in electrical equipment caused the death of 93 during the year.*

* * *

NEW REDUCED POWER RATES *for Portland, Ore., and vicinity have been announced by the Portland Electric Power Company and Northwestern Electric Company. Effective Dec. 1, the new schedules will affect over 4,000 users of industrial power.*

* * *

AUGUST SHIPMENTS *of oil burners, as reported by 50 manufacturers whose output constituted 60 per cent of the total for the industry in 1927, amounted to 10,663, as compared with 6,520 in July, according to the Department of Commerce.*

A.S.M.E. Announces Technical Program for Annual Meeting, Dec. 2-6

Ten Sessions Devoted to Power Subjects—Public Hearings on Power Test Code Planned—Dr. Bunge of Buenos Aires to Deliver Towne Lecture

ANNOUNCEMENT has recently been made of the technical program for the 50th annual meeting of the American Society of Mechanical Engineers to be held in New York City, Dec. 2 to 6. Ten sessions are being devoted to subjects related to the power field, including two public hearings on the power test codes. In all, 29 technical sessions will be held, and for the first time in the long history of A.S.M.E. annual meetings they will begin on Monday morning and continue through Friday afternoon.

This year the Henry Robinson Towne lecture dealing with some phase of the relation of engineering and economics will be delivered by Dr. Alejandro E. Bunge on Tuesday evening. Dr. Bunge is editor of the *Revista de Economia Argentina*, published at Buenos Aires, Argentina.

A full complement of entertainment features is planned for the meeting, including the ladies' annual get-together, Monday evening; a reception and dance, Tuesday evening; the annual dinner at the Hotel Astor, Wednesday; and the ladies' tea and college reunions on Thursday. A feature of the meeting is the National Exposition of Power and Mechanical Engineering, which will be held during the week at the Grand Central Palace.

Among the many interesting papers to be presented at the meeting, the following have direct bearing on the power field:

MONDAY

"Power—Steam or Hydro or Both," William W. Tefft; "Increased Kilowatt Output of Adjustable-Blade Propeller Turbines," C. R. Martin; "Mechanical Vibrations in Penstocks of Hydraulic-Turbine Installations," J. P. Den-Hartog; "Changing Requirements in Hydraulic Turbine Speed Regulation," Forrest Nagler; "Mechanics of Hydraulic-Turbine Pressure Regulation," A. Pfau; Progress Report of Hydraulic Division; power test codes public hearing; test code for liquid fuels.

TUESDAY

"Soot Particles in New York City Air," E. E. Free, and progress report of fuels division.

WEDNESDAY

"The Pioneer 1,800-Lb. Pressure Power Plant in America," W. E. S. Dyer; "Performance of Oil-Ring Bearings," George B. Karelitz; "The Service Characteristics of Diesel Engine Lubricating Oil," A. E. Flowers and M. A. Dietrich; test code for complete steam-electric power plants.

THURSDAY

"The Effect of Large Boilers Operated at High Capacities on the Operating Characteristics and Investment Costs of Boiler Plants," F. S. Clark; "Performance of Modern Steam-Generating Units," C. F. Hirshfeld and G. U. Moran; progress report of oil and gas power division; "Engineering and the Oil Industry," George L. Reid; progress report of special research committee on Diesel fuel oil specifications.

FRIDAY

"Recent Instances of Embrittlement in Steam Boilers," Frederick G. Straub; "Thermodynamics of Air Cooling," Barton H. Coffey (contributed by A.S.R.E.); "Engineering Computations for Air and Gases," Sanford A. Moss and C. W. Smith.

Work on Steam Plant Rushed to Relieve Shortage in Mexico

To relieve a serious hydro-electric power shortage in Chihuahua, Mexico, and the surrounding area, work of erection is being rushed on a 24-hr. schedule on the new Boquilla steam plant at Torreon by the Cia. Nacional de Electricidad. Completion of the initial installation of 12,000 kw. is expected early in January, 1930. When finished in April of next year, the new plant will have a total capacity of 27,000 kilowatts.

The power shortage occurred owing to an unusually low precipitation in this part of Mexico during the present year, and hydro-electric power supplied to the area by the Cia. Agricola y de Fuerza Electrica del Rio Conchos, S. A., a subsidiary operating company of the Electric Bond & Share Company,

New York City, was curtailed about 25 per cent. As the territory is now in the commencement of the dry season, there is not much hope for any considerable amount of precipitation for several months to come. Completion of the Boquilla station will allow power users to operate once more at full capacity, and also reduce the possibility of a similar shortage in the future.

N. Y. Power Group Discusses Generation

Generation and the development of generators was the subject considered at the Power Group meeting of the New York Section of the American Institute of Electrical Engineers, Wednesday evening, Oct. 30. The meeting, in quality of the papers, discussion and attendance, would have done justice to a national convention program. Two papers were presented by H. C. Forbes, research electrical engineer, New York Edison Company, and C. M. Gilt, inside plant engineer, Brooklyn Edison Company. The paper by Mr. Forbes dealt with high lights of generator development during recent years as viewed from the standpoint of the operating engineer.

At the East River station of the New York Edison Company, the 160,000-kw. unit has an output of 8,000 amp., which is considerably in excess of the carrying capacity of a single switch. This difficulty, and others involved in the design of such large capacity in a single unit, was overcome by using a double winding in the stator, each winding being connected to its own switch. Mr. Forbes said that, taking advantage of this method of increasing generator output without exceeding the limitation of related station equipment, it would appear that a 13,800-volt double-winding machine of approximately 240,000 kva. would be approaching what might be considered at least a temporary limitation.

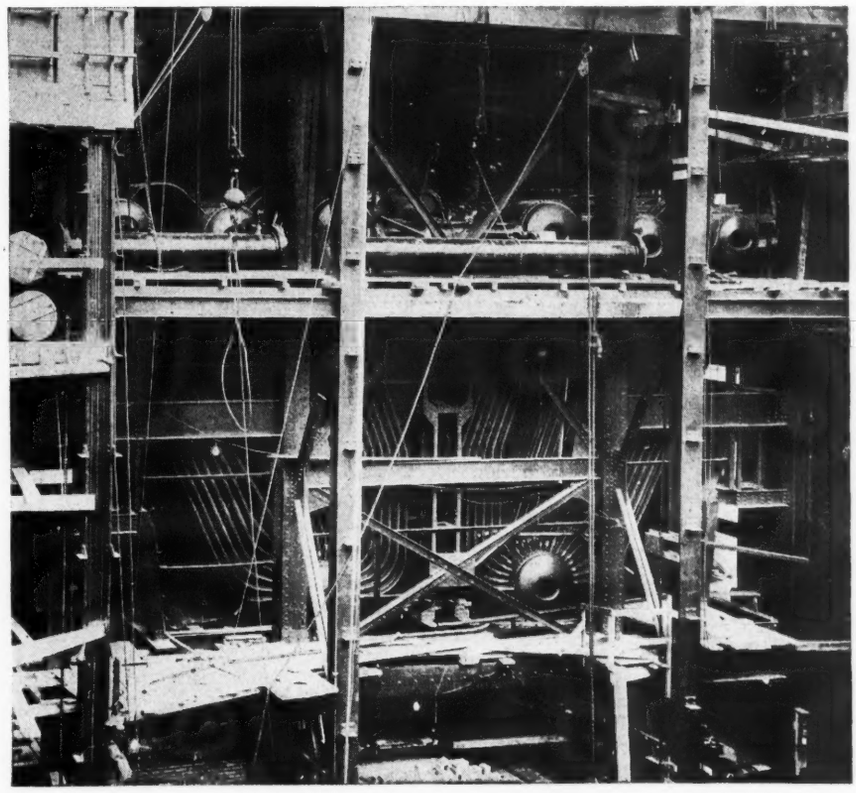
Since hydrogen cooling will increase the rating of machines about 25 per cent without increasing their dimensions, it would seem highly probable, according to the speaker, that hydrogen cooling for generators will constitute the basis of the next important increase in generator rating.

Mr. Gilt in his paper discussed the economic aspects of station design, using large units, and gave the reasons for large generators. It was Mr. Gilt's opinion that large generators were not installed to satisfy vanity, but they have been built to obtain cheaper capacity and reduce the cost of power.

Mr. Gilt presented a comparison of two designs of a 1,000,000-kw. station with spare capacity. One of the designs was for a station using 50,000-kw. units and, with spare capacity, requiring 24 machines, or a total capacity of 1,200,000 kw. The other plant was assumed to have ten 150,000-kw. units, including the spares, or 1,500,000-kw. capacity. The cost of the plant with the small units was given as $120 per kw. and that of the plant with the large units was placed at $80 per kw. The total annual costs for the design with the 50,000-kw. units was given as $31,900,000, and for the other design $27,000,000.

F. W. Gay, Public Service Production Company, gave an interesting talk, during which he explained a suggested method of cooling large generators with carbon dioxide instead of air. The coolers were to be installed in the ventilating ducts of the machines in such a way that in case of short circuits in the generator the carbon dioxide would be released to extinguish the fire. Thus the carbon dioxide would serve the dual purpose of cooling the machine during normal operation and acting as a fire extinguisher if a winding failure occurred.

Boiler Plant Addition Nears Completion in New York Steam Corp. System



Recent construction photograph of the new addition to Station A, showing the two Heine V type boilers

THE new addition to the New York Steam Corporation's Station A, located at Burling Slip and Pearl Street, New York City, will be producing steam around the first of next month. Rapid progress is being made on the installation of two Heine V type boilers with a combined capacity of 360,000 lb. of steam per hour. Fired by twin Coxe stokers, the boilers are equipped with economizers and cinder catchers. Each boiler has two induced-draft fans, turbine driven through gears. The forced draft system is interconnected with the old station.

The plant will receive its coal by truck from nearby piers and has a coal storage capacity of approximately one week's supply. The fuel used will be the same as in the existing station, No. 3 buckwheat anthracite, and will be handled by bucket elevators and belt conveyors. Ash will be handled by industrial railway cars, skip hoists, elevators.

N. Y. Committee of 25 Gives First Report

Substitution of unbiased business methods for political machinations in dealing with general tax revision, public expenditures, power, agriculture, conservation and the barge canal in New York State was strongly recommended by the Committee of Twenty-Five in its first report, made public recently. Unless drastic and immediate action along these lines is taken, the committee believes, industrial development in the state will continue to dwindle.

Development at once of New York's potential hydro-electric power is particularly stressed in the report. More than half of the state's vast power resources is still undeveloped, it is

pointed out, and this has been a strong factor in discouraging manufacturing enterprise. The committee proposes to appoint a sub-committee on power which will include no person substantially interested in any way with the production or distribution of power. The sub-committee will study the power situation in all its phases and recommend a course of action for the state to follow.

The Committee of Twenty-Five is an outgrowth of the New York State-Wide Economic Congress held in New York City, April 17, 1929, at which, as reported in *Power* of June 11, consideration was given to the decline in manufacturing industry in the state and the effect of changing economic conditions on the welfare of the people. This congress appointed 25 representative business men to study the situation and formulate plans for improvement.

Surveys to Start in Austria on Gigantic Hydro Project

Preliminary surveys are about to be made in Austria on what is known as the Tauern Wasserkraftwerke, a gigantic hydro-electric scheme planned by the province of Salzburg in conjunction with the A.E.G., of Berlin. It is understood, however, that a considerable time must elapse before the scheme is proved definitely feasible. Afterwards the question of the justification for certain anticipations and the correctness of the figures presented will have to be investigated, and, lastly, it will be necessary to inquire whether the investment would be profitable and whether the necessary capital could be obtained. All that is definite today is that Dr. Rehrl, Governor of Salzburg and prime advocate of the project, has succeeded in persuading the A.E.G. to have the technical side of the project investigated at that concern's own cost.

Should the project be carried through, it will be both the largest and most remarkable of its kind in Europe. The intake is to be at an altitude of 7,600 ft. The annual production of the plant is estimated at 6,000,000,000 kw.-hr., or twice the power to be generated by the twenty hydro-electric power plants now under construction in Austria, when added to the 1,700,000 kw.-hr., which represent Austria's present production.

License Law for Contractors Effective Nov. 1 in Calif.

On Nov. 1, a new law went into effect in California, requiring all contractors of any kind in the state to be licensed by the state. This is in addition to any local license regulation under which their own particular business falls, and applies to all whose gross construction and material cost for any work undertaken amounts to $200 or over. Other exemptions to the provisions of the law apply to contractors engaged in construction work incidental to irrigation, drainage and farming; public utilities on work incidental to their own business; and sole owners building structures on their own property for their own use.

One section of this new law is particularly noteworthy because it provides stringent rules governing contractors' conduct in business. Its provisions are as follows:

"Any person, firm, corporation or organization may file with the registrar verified complaint charging a licensee with one or more of the following acts or omissions: (1) abandonment of contract without legal excuse; (2) diversion of funds from any contract, and their application to another contract, with intent to defraud or deceive creditors or owner; (3) fraudulent departure from or disregard of, plans or specifications without consent of owner, or doing of any willful, fraudulent act as a contractor which substantially injures another; (4) willful or deliberate disregard or violation of the building code, or safety or labor laws, under which the licensee may be operating."

Business Good for Rest of Year

THE basic soundness of American business and industry today is stressed by Robert M. Davis, statistical editor of the McGraw-Hill Publishing Company, in a recent report on business conditions. Mr. Davis points out that the remainder of the year looks good in practically all branches of the various fields covered by the 26 McGraw-Hill publications. General manufacturing is currently slightly above this time last year and should continue on a high plane during the remainder of the year. Volume of general business should average about 5 per cent over last year. Engineering construction is 20 per cent ahead of last year; textile manufacturers are balancing production with a slowly increasing demand; a record volume of orders is expected by the machine tool industry; aviation merchandising is up to expectations; electric railway income is rising due to peak rates of fares; numerous large expansion programs are being announced in the modernization of industrial plants; the continuation of orders and demand give an appearance of greater activity in the general chemicals market; the upward swing is being maintained in bituminous coal mining; balanced production and demand is being maintained in the metal mining field; and electric light and power operations will be maintained on a plane about 10 per cent above last year.

Boiler Plant Being Erected for Dalhousie Mill

To furnish steam for the operation of the new four-machine paper mill of the International Paper Company at Dalhousie, N. B., a modern boiler plant is now being erected. Two 12,000-sq.ft. boilers designed for 400 lb. pressure and using pulverized coal are being installed. They will be equipped with water walls and air preheaters. Steam from these boilers will be fed to a 6,000-hp. turbine-generating unit to reduce the pressure to 125 lb. for process work.

The generator will operate in parallel with the hydro-electric plant of the St. John River Power Company at Grand Falls, which will supply 40,000 hp. for the regular operation of the four paper-making machines. Surplus power will be used to generate steam in a 1,600-kw. electric boiler. Completion of the plant is scheduled for the early part of next year.

Weights and Measures Act Now Before Congress

A resolution relating to the establishing of commodity quantity units for general use in merchandising after 1935 is now pending before Congress. It is expected the bill will be taken up at the next regular session in December.

Deploring the lack of uniformity in the weights and measures of the United States at the present time and advocating the adoption of the metric system, the resolution provides "that the Department of Commerce be authorized and directed to conduct, within one year, a thorough investigation and study to determine the advisability of adopting metric weights and measures for general use in the United States. This department, after making such investigation and study, is hereby authorized to initiate and carry out, to such extent as may be deemed advisable, plans to encourage the general and common use in the United States of such system of weights and measures."

License Granted for Plant on Columbia River, Wash.

The Washington Electric Company, Seattle, Wash., a subsidiary of the Puget Sound Power & Light Company, Seattle, has been granted a license by the Federal Water Power Commission for a project at Rock Island, on the Columbia River, near Wenatchee, with an initial capacity of 60,000 kw. A. W. Leonard, president of the Puget Sound Power & Light Company, expressed gratification over granting of the license, stating this enables the company to go ahead with a project that will cost from $10,000,000 to $12,000,000 for the first unit, and ultimately will run to a much greater sum and a total capacity of 180,000 kw. The company hopes to complete the first unit by 1933.

News of Canada

Nova Scotia Regulations for Engineers

IN THE province of Nova Scotia a power engineer does not require any certificate to operate a plant within the jurisdiction of the Factory Act, only operations within the provisions of the Coal Mines Regulation Act, in other words, mines, requiring licensed engineers.

In the mining field certificates of competency are issued by the Minister of Public Works of the province, on the recommendation of a board of examiners, consisting of the inspector of mines, a mechanical engineer of recognized ability and a mining engineer of approved standing. Examinations are held annually; the province, for this purpose, being divided into four districts: Cumberland, Pictou, Inverness and Cape Breton. The regulations provide for the licensing of first-, second- and third-class engineers.

Applicants for first-class certificates are required by the board, among other things, to show that: they are at least 24 years of age; hold a second-class certificate, have served a year at mechanical work on machinery; have for a year been in charge of a hoisting or haulage engine, or for two years in charge of an engine other than that last-mentioned; or hold a second-class certificate and have been engineer in charge of a steam plant for twelve months, or have served at mechanical work in a machine shop for three years.

Applicants for second-class certificates must show that they are at least 21 years of age, hold a third-class certificate and have been employed as a third-class engineer for not less than a year.

Candidates for third-class certificates must be not less than 18 years of age, prove that they have served not less than six months as a fireman; or have served at least twelve months as engineer, assistant engineer, pumpman, oiler or locomotive engineer; or have served at least 18 months in a machine shop.

The experience of any engineer outside of the province of Nova Scotia may be accepted by the board if it deems the same of equal value to that within the province. Fifteen hours is given applicants for all grades of certificates to furnish written answers to the 50 questions asked, the examination for each grade being divided into five papers, on first-aid work, engines, boilers, pumps, compressed air and electricity.

1930 Census to Include Power Statistics

A compilation by industries showing the rate of increase in the use of power is being considered by the electrical division of the Department of Commerce. Such a survey has been made possible by the decision of the Census Bureau to obtain more complete information on the use of power in this year's census of manufacturers. The questionnaire has been drawn up to provide a double check on the power purchased by the various manufacturers.

In one place on the questionnaire power is listed as a separate item, while later on it is mentioned under the heading of fuels purchased. Provision is also made for finding out for the first time the amount acually expended each year for power. Efforts are being made to segregate more clearly the power produced by manufacturing establishments in their own plants. To carry out the survey even further, it has been proposed that information be compiled from the returns listing the reasons why some industries maintain their own power plants.

Under this plan the industries shown to be the largest producers of their own power would be sent questionnaires asking them to relate the reasons why they believe this method is the best suited to their business.

Coming Conventions

American Institute of Electrical Engineers. District meeting at Chicago, Ill., Dec. 2-4. Annual winter convention at New York, N. Y., Jan. 27-31, 1930. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Mechanical Engineers. Annual meeting at New York, N. Y., Dec. 2-6. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Twenty-Fifth Anniversary Meeting at Hotel Pennsylvania, New York City, Dec. 4-7. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

International Heating & Ventilating Exposition. Commercial Museum, Philadelphia, Pa., Jan. 27-31, 1930. Manager, C. F. Roth, Grand Central Palace, New York City.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National Marine Engineers' Beneficial Association. Annual convention at Hotel Barlum, Detroit, Mich., the week of Feb. 10, 1930. Secretary, A. L. Jones, 9th St. and Mount Vernon Place, N. W., Washington, D. C.

Stoker Manufacturers Association. Fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Nov. 11-13.

Commercial Bribery Illegal, Court Rules

Commercial bribery, dragged to the judical fire by the Federal Trade Commission, has, for the first time on record, been branded "illegal" by a Federal Court, according to a report in the Oct. 26 issue of *The Business Week*. The United States Circuit Court of Appeals for the Sixth District, Cincinnati, has ordered the Grand Rapids Varnish Company to "forthwith cease and desist from directly or indirectly secretly giving, or offering to give, employees of its customers or prospective customers, without the knowledge or consent of their employers, as an inducement to cause their employers to purchase or contract to purchase from the respondent, varnish and kindred products, or to influence such employers to refrain from dealing, or contracting to deal, with competitors of respondent, without other consideration therefor, money or anything of value."

In former days, such practices as these were quite common in the power plant equipment field, but recently they have been frowned upon to such an extent that they are gradually disappearing. The few who still pursue them should heed this court decision.

American Locomotive Buys McIntosh & Seymour

William H. Woodin, chairman of the board of the American Locomotive Company, announced Oct. 31 the acquisition by his company of the McIntosh & Seymour Corporation of Auburn, N. Y., manufacturers of Diesel engines for marine, stationary and transportation use, according to a dispatch in the New York *Times* of Nov. 1. The acquired company was famous years ago for its steam engines, and in 1914 turned its attention to the Diesel engine, of which it is today the largest exclusive maker in this country.

Mr. Woodin said the purchase was in furtherance of the policy of the American Locomotive Company to participate in every development which promised to add to the efficiency of the railroads, and also to meet the growing demand for Diesel engines for rail motor cars, buses and tractors.

The purchase would require no new financing on the part of the American Locomotive Company, Mr. Woodin said. The corporation would continue under the present management, but as a subsidiary of American Locomotive. The two companies collaborated in the design and production of the first oil-electric passenger locomotive to be placed in service by a railroad in the United States.

ACCORDING TO REPORTS received by the Bureau of Mines, Department of Commerce, the production of crude petroleum in the United States during September, 1929, amounted to 87,269,000 barrels

PERSONALS

LESTER P. BRECKINRIDGE, professor emeritus of mechanical engineering at Yale University, is sailing for Italy, Nov. 9, on the SS. Biancamano.

LAVINIA BROWN HOXIE, widow of the late William D. Hoxie, is holding a house warming this Saturday in the new home of the president of Stevens Institute of Technology, money for the building of which she donated. Mr. Hoxie, formerly vice-chairman of the Babcock & Wilcox Company, was graduate from Stevens Institute with the class of 1889.

LEWIS H. BROWN, president of the Johns-Manville Corporation, and Dr. Harvey Fletcher, research engineer with the Western Electric Company, are among those appointed to New York City's noise commission, the first body of its kind ever named officially to study the problems created by the din of a modern city.

GEORGE KIDD, president of the British Columbia Power Corporation, Vancouver, B. C., has been appointed official delegate of the Canadian Manufacturers' Association to the conference of the Institute of Pacific Relations at Kyoto, Japan.

FRANCIS J. ADAMS, professor of electrical engineering at Worcester Polytechnic Institute, has been granted a leave of absence to work temporarily with the New England Power Construction Company, of Boston.

MARY O. SOROKA, formerly with H. G. Balcom, Spencer, White & Prentis and Purdy & Henderson Company, both of New York City, has taken a position as engineer in the hydraulic division of the Stone & Webster Engineering Corporation. Miss Soroka graduated from Massachusetts Institute of Technology in 1926.

L. D. WEST, formerly assistant general manager of the Metropolitan Edison Company, Reading, Pa., has been appointed vice-president of the J. G. White Management Corporation, of New York City. Among other positions he has held since graduating in mechanical and electrical engineering from Cornell University are power engineer for the United Light & Water Company, of New England, and superintendent of steam heating for the Cleveland Electric Illuminating Company.

E. M. SCHOFIELD, engineering contractor, and head of the Schofield Engineering Construction Company, has been appointed a member of the Los Angeles Board of Water and Power Commissioners.

With the Society Sections

A. S. M. E., Boston Section. Meeting Nov. 13, Engineers' Club at 7:45 p.m. Subject: "Lubrication," by Prof. A. E. Norton, Harvard Engineering School. Professor Norton has been doing research work on the subject and has much valuable data. Motion pictures will also be shown.

A. S. M. E., Bridgeport Section. Meeting Nov. 14, University Club, Golden Hill St., Bridgeport, Conn. at 8:15 p.m. Subject: "Refrigeration Practice of Today," by R. H. Greene, past-president of the American Society of Refrigerating Engineers. Ernest Hartford assistant secretary of the A. S. M. E., will discuss the matter of licensing engineers.

A. S. M. E., Metropolitan Section. Power meeting, Nov. 8, sponsored by the power division of the A. S. M. E.; chairman, Dr. Harvey N. Davis, president of Stevens Institute of Technology. Subject; "Recent Developments in European Power Plants," by Joseph H. Keenan, professor of mechanical engineering, Stevens Institute.

A. S. M. E., San Francisco Section. Meeting, Nov. 7, Engineers' Club of San Francisco, at 7:30 p.m. Subject: "Licensing of Engineers," by L. F. Levrey, W. Stalder, C. H. Snyder and J. D. Galloway These speakers are to give their ideas pro and con.

A. S. M. E., Worcester Section. Meeting, Nov. 7, C. T. Sherer Company's restaurant, at 6:30 p.m. Subject: "The General History of Mechanical Refrigeration," by F. L. Fairbanks, chief engineer of Quincy Market, Boston, Mass.

National Research Council. Committee on electrical insulation of the Division of Engineering and Industrial Research will hold annual meeting at Massachusetts Institute of Technology, Cambridge, Mass., Nov. 14-16.

BUSINESS NOTES

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., announces the inauguration on Nov. 6 of a series of radio programs devoted to popularizing America's great industries. Something of the history and romance of one individual industry will be portrayed each week. The programs will be broadcast every Wednesday at 7:30 p.m. over the National Broadcasting Company's blue net work.

TOLEDO PIPE THREADING MACHINE COMPANY, Toledo, Ohio, is building a new addition to its plant which will increase its manufacturing floor space by 45 per cent. The new addition will be in operation by Jan. 1, 1930.

WAGNER ELECTRIC COMPANY, St. Louis, Mo., announces the removal of two branch sales offices. The Milwaukee office has been moved from 501 Broadway to 525-27 Broadway. The St. Louis office has been moved from 505 Shell Building to 909-9 Plaza Olive Building.

CHAIN BELT COMPANY, Milwaukee, Wis., has opened a New England district office in Boston, at 950 Park Square Building. This makes the eighteenth district office the company has opened in the United States within the past few years. J. K. Merwin, formerly with the Stearns Conveyor Company at Cleveland, is in charge of the new Boston office.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.10 @ $2.45
Kanawha	Columbus	1.30 @ 1.60
Smokeless	Cincinnati	2.25 @ 2.50
Smokeless	Chicago	2.10 @ 2.25
S. E. Kentucky	Chicago	1.30 @ 1.60
Steam	Pittsburgh	1.40 @ 1.75
Gas Slack	Pittsburgh	1.00 @ 1.10
Big Seam	Birmingham	1.50 @ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$2.65@ 2.75
Barley	New York	1.40@ 1.50

FUEL OIL

New York—Oct. 24, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Oct. 11, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.5959 per bbl. or 42 gal.; 26@28 deg., $1.6459 per bbl.; 28@30 deg., $1.6959 per bbl.; 30@32 deg., $1.7459 per bbl.; 32@36 deg., gas oil, 4.901c. per gal.; 37@40 deg., distillate, 5.98c.

Pittsburgh—Oct. 16, f.o.b. local refinery, 30@34 deg., fuel oil, 4c. per gal.; 36@40 deg., 4.25c. per gal.

Philadelphia—Oct. 18, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—Oct. 22, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Oct. 9, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 95c.@$1.00 per bbl.; 30@32 deg., $1.20 per bbl.

Boston—Oct. 21, tank-car lots, f.o.b., 12@14 deg., Baume 4.5c. per gal.; 28@32 deg., 5.62c. per gal.

Dallas—Oct. 19, f.o.b. local refinery, 26@30 deg., $1.30 per bbl. or 42 gallons.

TRADE CATALOGS

INSTRUMENTS—A new 28-page bulletin No. 115-2, entitled "Foxboro Instruments in the Power Plant," has just been issued by the Foxboro Company of Foxboro, Mass. Well-illustrated, the bulletin contains brief descriptions and applications of various instruments for measuring and recording temperature, pressure and flow, as these affect the efficiency of the power plant.

VALVES—A condensed catalog, Bulletin S-10, covering feed-water regulation, pressure regulation and condensation control has been issued recently by the Swartout Company, 18511 Euclid Ave., Cleveland, Ohio. Short descriptions of separators, feed water heaters and ventilators are also included.

UNIT HEATERS—A 16-page booklet outlining the salient features of industrial unit heating has recently been published by the Grinnell Company of Providence, R. I. It explains the fundamental considerations governing the choice of a heating system, and illustrates the fourteen constructional features of the Grinnell industrial-type Thermolier.

GENERATORS — Electroplating generators are described in detail in the new 16-page bulletin issued by the Columbia Electric Manufacturing Company, 1292 East 53rd St., Cleveland, Ohio. Many illustrations show the constructional features of these machines.

CONDENSERS—A description of surface condensers as manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is given in leaflet 20409, a recent publication of that company. Besides describing the construction of the condensers, the leaflet contains considerable application data.

MOTORS — Type E explosion-proof electric motors are fully described with their applications in a 12-page illustrated bulletin, No. 508, just issued by the Louis Allis Company, of Milwaukee, Wis. The motor has been approved by the Underwriters' Laboratories as safe for operation in explosive atmospheres.

WELDING — Bulletin No. 4 of the Fusion Welding Corporation, 103rd St. and Torrence Ave., Chicago, Ill., gives pertinent data on Type S welding rod, developed for welding 18-8 chrome-nickel and similar alloy steels.

CEMENT—Quigley acid-proof cement used extensively in stack construction is fully described in an illustrated booklet just issued by the Quigley Furnace Specialties Company, 56 West 45th St., New York City.

STEEL—"Products and Publications" is the title of a 52-page booklet issued by the United States Steel Corporation, of New York City, which lists the products, byproducts, publications and sales office addresses of all subsidiary manufacturing companies of the corporation.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Russellville—City, C. C. Nugent, Mayor, called off bond election for $250,000 for the construction of a power plant and distribution system, also installation of two 600 hp. and one 360 hp. Diesel engines. Project abandoned for the present.

Calif., Los Angeles—Banks-Huntley & Co., Stock Exchange Bldg., awarded contract for the construction of a 13 story office building at 634 South Spring St., to Edwards, Wildey & Dixon, Edwards & Wildey Bldg. Estimated cost $1,000,000. Steam heating system, and electric elevators, etc., will be installed.

Calif., Los Angeles—H. Feigenbaum, Union Bank Bldg., will build a 6 story, 135 x 140 ft., apartment building, Rosemore Ave. and Clinton St. Estimated cost $700,000; also 5 story apartment, Oxford, 5th and 6th Sts. Estimated cost $500,000. M. Maltzman, 420 Union Bank Bldg., is architect. Work will be done by separate contracts.

Calif., Los Angeles—H. G. Ferguson Corp., 330 Schuyler St., Beverly Hills, is receiving bids for the construction of a 13 story office building including steam heating system, elevators, etc. at 6th and Flower Sts. Estimated cost $1,500,000. Walker & Eisen, Western Pacific Bldg., are architects.

Calif., Modesto—County of Stanislaus, will receive bids until Nov. 13 for the construction of a hospital ward building and power house. R. G. DeLapp, Oakland, is engineer.

Calif., San Francisco—State Harbor Commission, Ferry Bldg., will receive bids until Nov. 13 for the construction of a cold storage terminal at Pier 48. Estimated cost $250,000. F. G. White, Ferry Bldg., is engineer.

Conn., Windsor Locks—Northern Connecticut Power Co., 15 Central St., Thomasville, will not construct power house and two dams here. Project abandoned. Noted May 27, 1928.

Fla., Fort Myers—J. Spadero, plans the construction of a cold storage plant. Estimated cost $100,000.

Fla., Sarasota — J. N. McDonald has been granted permit by Federal Power Commission to construct a hydro-electric plant on Oklawaha River, 16,000 hp. capacity.

Ill., Chicago — National Bank of Republic, 150 West Adams St., is having sketches made for the construction of a 40 story bank and office building at 158-164 Adams St. Burnham & Burnham, 160 North La Salle St., are architects.

Ind., Jasper—Hoosier Desk Co. awarded contract for the construction of a power house and dry kiln including one 250 hp. water tube boiler to C. Keller, 818 Dubois St., Vincennes. Estimated cost $40,000.

La., Baton Rouge—Standard Oil Co. of Louisiana and Louisiana Steam Products Inc., subsidiary of Engineers Public Service Co., will build a steam and electric power plant near here to supply 6,000,000,000 lbs. steam annually, electric generating plant to have 60,000 hp. capacity. Estimated cost approximately $6,000,000. Stone & Webster, 49 Federal St., Boston, Mass., are engineers and builders.

Mass., Allston (Boston P.O.)—Boston & Albany R.R., South Station, Boston, will soon award contract for the construction of power house to include two 450 hp. Sterling boilers, coal conveyors, pulverizers, etc., at Beacon Park here. Estimated cost $225,000. G. A. Kirley, is chief engineer.

Mass., Roxbury (Boston P.O.)—New England Baptist Hospital, 93 Parker Hill Ave., Roxbury, awarded contract for the construction of a boiler room and service building addition to H. W. Burke, 137 Ferncroft Rd., Milton.

Mass., Salem—Essex Institute of Salem, H. W. Belknap, 132 Essex St., plans the construction of a boiler room, etc. Estimated cost $100,000. Architect not selected.

Mass., West Mansfield—City, F. E. Briggs, Mayor, awarded contract for the construction of a pumping station and driven wells in connection with waterworks to Munroe & Westcott, Commercial Bldg., North Attleboro. Estimated cost $40,000.

Mich., Eloise—Wayne Co. Bd. Poor Commissioners County Bldg., will receive bids until Nov. 12 for the construction of 5 story, 130 x 250 ft. hospital, Michigan Ave. Estimated cost $500,000. Maul & Lentz, 1257 David Whitney Bldg., are architects. Steam heating, elevators, refrigerating, boilers, etc., will be installed.

Mich., Flint—Union Industrial Trust & Savings Bank, awarded contract for the construction of 15 story, bank and office. South Saginaw St. to Realty Constr. Co., 502 Industrial Bank Bldg. Estimated cost $1,000,000.

Mich., Lansing—R. E. Olds Co., Capitol Bank Bldg., awarded contract for the construction of a 22 story bank and office building, including steam heating and ventilation systems, boilers, elevators, etc., on Allegan St., to Hutter Construction Co., Fond du Lac, Wis. Estimated cost $1,500,000.

Miss., Wiggins—City will soon award contract for waterworks improvements including deep well pump, motor driven fire pump, etc. Shaw & Woleben, Gulfport, are engineers.

Mo., Lebanon—Central States Power & Light Co., c/o Central States Utilities Co., Chicago, Ill., awarded contract for the construction of a hydro-electric plant and dam 17 ft. high and 400 ft. long on the Niangua River near here, to Management & Engineering Corp., Dubuque, Ia. Plans include power plant, two generating units of 12,000,000 kw. hr. per year capacity, tunnel 13 ft. sq., etc. Estimated cost approximately $5,000,000.

Neb., Lincoln — Iowa Nebraska Light & Power Co., 9th and L Sts., will build a power plant, including boiler room, turbine room, switch bay rooms, etc., at 9th and K Sts. Estimated cost $120,000. Work will be done by owners' forces. Boilers, stokers, turbines, motors, economizers, etc., to cost $75,000 will be installed.

N. J., Asbury Park—Berkeley Carteret Hotel, A. C. Steinbach, Prop., Cookman Ave., is having plans prepared for the construction of a 10 story addition to hotel including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. at Ocean Ave. and 6th Ave. Estimated cost $500,000. Warren & Wetmore, 16 East 47th St., New York, N. Y., are architects.

N. J., Asbury Park—E. H. Schnieder, Third Ave., Spring Lake, Archt., will receive bids about Nov. 1 for the construction of an 11 story apartment building including steam heating and refrigeration systems, boilers, elevators, etc. at Grand and 5th Aves. here for Peoples Building & Construction Co., 218 Sanford St., New Brunswick. Estimated cost $500,000.

N. J., Jersey City—Pennsylvania Dock & Warehouse Co., 25 Church St., New York, N. Y., will build fourth unit of cold storage warehouse and terminal here. Estimated cost to exceed $150,000. G. F. Bial, 145 Summit Ave., Union City, N. J., is architect.

N. J., Mount Mitchell—Syndicate, T. Mason, Pres., c/o H. H. Marshall, 37 West 43rd St., New York, Archt. and Engr., will receive bids about Dec. 1 for the construction of a 6 story hotel, etc., including steam heating, ventilation and refrigeration systems, boilers, elevators, etc., here. Estimated cost $2,500,000.

N. J., Pinewald—F. B. Durant, Supt., c/o Sangor Hotel Corp., 60 Park Pl., Newark, is receiving bids for general refrigeration plant, steam driven ammonia type condensers, also ventilation system and smoke breeching in connection with proposed hotel at Crystal Lake Shore, here. Estimated cost $1,000,000. W. K. Oltar-Jevsly, 130 West 42nd St., New York, is architect. Sprague & Slocum, 12 East 42nd St., New York, are engineers.

N. J., Sayreville—Eastern New Jersey Power Co., is receiving bids for the construction of a 4 story power plant. Estimated cost $1,000,000. Management & Engineering Corp., 327 South La Salle St., Chicago, Ill., is architect and engineer.

N. Y., Brooklyn—Rubel Coal & Ice Corp., 937 Fulton St., plans the construction of a 127 x 218 ft. ice manufacturing plant at West 21st St. and Neptune Ave. Estimated cost $90,000. H. J. Nurick, 44 Court St., is architect.

N. Y., Ithaca—Cornell University, awarded contract for addition to heating plant to Jackson, Robertson & Adams, 1216 Turks Head Bldg., Providence, R. I.

N. Y., Long Island City—New York & Queens Light & Power Co., Bridge Plaza, is receiving bids for the construction of a 9 story office building, etc., at Roosevelt Ave. and Lawrence St. Estimated cost $1,075,000. T. R. Eilenberg, 40-22 Lawrence St., is architect. Contract for foundations awarded.

N. Y., New York—Dept. of Parks, will readvertise for new bids for the construction of a power house and service building for American Museum of Natural History, Columbus Ave. and 77th St. Former bids rejected.

O., Delta—City plans an election Nov. 5 to vote $100,000 bonds for the construction of a waterworks system including pumping station, etc.

Okla., Blackwell—City plans an election Nov. 12 to vote $75,000 for a new 2500 kw. steam turbine unit. C. O. Stoldt, is engineer.

Ore., Portland—Meier & Frank, 6th and Morrison Sts., will receive bids after Nov. 15 for the construction of a 14 story stores building, including steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc. Estimated cost $2,000,000. De Young, Moscovitch & Rossenberg, 11 East 44th St., New York, N. Y., are architects and engineers.

Pa., Greenville—Thiel College. E. C. Xander, Pres., College St., Greenville, Pa., plans the construction of a central heating plant.

Pa., Philadelphia — Presbyterian Hospital, Powelton and Saunders Sts., awarded contract for the construction of a 5 story hospital and dispensary to Irwin & Leighton, 1505 Race St. Estimated cost $1,200,000.

Pa., Philadelphia—Real Estate Assets Corp., c/o E. G. Gross, 123 South Broad St., plans the construction of a 26 story office building at 1505-1509 Spruce St. Estimated cost $3,000,000. Ritter & Shay, Packard Bldg., are architects.

Tex., Austin—University of Texas, c/o J. W. Calhoun, Comptroller, will receive bids until Nov. 8 for the construction of a 4 story chemistry building on Campus. Estimated cost $1,000,000. La Roche & Dahl and H. M. Greene, 307 Construction Independence Bldg., Dallas, are associate architects.

Tex., Big Springs—W. R. Settles, Big Springs, plans the construction of 15 story 100 x 140 ft., hotel, including steam heating, D. S. Castle, Alexander Bldg., Abilene, is architect.

Tex., Dallas — Dallas Power & Light Co., Interurban Bldg., plans the construction of an 18 story office building at Browder and Jackson Sts. Estimated cost $1,250,000. Lang & Witchell, American Exchange Bank Bldg., are architects.

Tex., Leveland—City voted $48,000 bonds for waterworks improvements including distribution lines, pumping equipment, etc.

Tex., Mercedes—Alford Pure Milk & Ice Co., c/o R. W. Alford, 819 South Presa St., San Antonio, awarded contract for the construction of a 1 story ice plant at Highway and Missouri Pacific Ry. to H. J. Lawson, 321 Texas Ave., Mercedes. Estimated cost $75,000.

Tex., Paint Rock—Stock Co., c/o Chamber of Commerce, is having preliminary surveys made for the construction of a limestone quarry, electrically operated. Estimated cost $100,000. Private plans.

Tex., San Antonio—U. S. Government, War Dept., c/o A. W. Parker, Quartermaster, will receive bids until Jan. 20 for the construction of a post exchange building, including cold storage plant at Randolph Flying Field.

Va., Covington — Virginia Public Service Co., F. W. King, V. Pres., Charlottesville, had surveys made for the construction of a hydro-electric plant here. Estimated cost $3,000,000.

B. C., Powell River—Powell River Co. Ltd., is having plans prepared for the construction of a hydro-electric power plant. 32,000 hp. capacity on Lois River, also additional buildings to paper mill to increase output, 35,000 tons per year. Estimated cost $8,000,000. P. Sandwell, c/o owner, is resident engineer.

Ont., Ottawa—Dept. of Public Works, will receive bids until Dec. 3, for the construction of a 4 story, 150 x 420 ft. national research laboratory building at Sussex St. Estimated cost $2,500,000. T. W. Fuller, c/o owner, is architect. Power to be used will be developed from the Rideau Falls which are on the site.

Ont., Toronto—Canada Life Assurance Co., 46 King St. W., awarded contract for the construction of an 8 and 11 story office building to Anglin-Norcross Ltd. Temple Bldg. Estimated cost $2,000,000. Steam heating system, elevators, etc. will be installed.

Quebec — Beauharnois Power Co. will award contracts within the next six months for sixteen locomotives, one-hundred dump cars, two locomotive cranes, electric transformers, rock crushing equipment, etc. $3,000,000. Contract for electrical equipment for excavating unit awarded to Canadian General Electric Co. of Toronto, 212 King St. W. Work will be done under the supervision of Beauharnois Construction Co., subsidiary of owner.

Equipment Wanted

Boilers, Stokers, Boiler Breeching and Coal Handling Equipment—Cincinnati, O.—Bd. of Education, Administration Bldg., 216 East Ninth St., will receive bids until Nov. 25 for boilers, stokers, boiler breeching and coal handling equipment, etc. for proposed high school at Walnut Hills and Blair Ave.

Condensers, Pumps, Generators, etc.—Detroit, Mich.—Dept. of Water Supply, D. C. Grobbel, Acting Secy., 735 Randolph St., will receive bids until Nov. 13, for three surface condensers for 500 kw. turbine generators, three circulation water pumps, three twin combination two-stage steam jet air ejector pumps with common inner and after condensers, three condensate pumps, three 500 kw. steam turbine generators, horizontal shaft type without condensing equipment for proposed waterworks.

Engine, Generator Units, etc.—Polk, Pa.—Polk State School, H. M. Watkins, Supt., will receive bids until Nov. 15 for a new engine, generator units, and appurtenances for proposed improvements to power house. Estimated cost $70,000.

Generator—Central Falls, R. I.—F. A. Pigeon, 16 River St., plans to purchase a steam driven generator, direct connected, 50 kw. 60 cycles, 220 v.

Generator, Etc.—Lynn, Mass.—L. Barret, 25 Buffam St., plans to purchase a generator, 150 amp., 12 v., etc.

Generators—Wards Island, N. Y.—Dept. of Mental Hygiene, Capitol, Albany, will receive bids until Dec. 4 for two 300 kw. generators for Manhattan State Hospital here.

Pumping Equipment—Mulberry, Ark.—Waterworks and Sewer Improvement Dist. No. 1. J. D. Crokett, Chn., will soon receive bids for pumping equipment, etc. for proposed waterworks improvements.

Pumping Units—Blissfield, Mich.—Village plans to purchase motor driven centrifugal pumping units, etc. for proposed waterworks improvements. Estimated cost $50,000.

Pumps—Sylvan Lake, Mich.—Village, plans to purchase electric motor driven pumps, 14,600 and 14,000 g.p.m. for proposed sewage system. Estimated cost $200,000.

Pumps, Etc.—Franklin, Neb.—City, C. J. Goetz, Clk, will receive bids until Nov. 8 for two motor driven centrifugal pumps, etc. for proposed waterworks improvements. Estimated cost $15,000.

Pumps, Etc.—Genoa, Neb.—City, J. Paulson, Clk, will receive bids until Nov. 8 for two triplex pumps, direct connected to 15 hp. a.c. motors, etc. for proposed waterworks improvements.

Stoker—Boston, Mass.—Bureau of Yards & Docks, Navy Dept., Washington, D. C. will receive bids until Nov. 6 for an underfeed mechanical stoker at Navy Yard, here.

Industrial Projects

Calif., San Francisco—Pacific Gas & Electric Co., 445 Sutter St., awarded contract for the construction of group of service buildings, Folsom and 18th Sts. to Monson Bros., 475 6th St. Estimated cost $300,000.

Ind., Indianapolis—Westinghouse Electric Co., 814 North Senate St., plans the construction service station building, 551 West Maryland St. Estimated cost $65,000. C. Byfield, 923 Peoples Bank is architect.

Ky., Louisville—American Cigar Co., 317 Roland St., awarded contract for the construction of a 4 story 80 x 200 ft., cigar factory, 30th and Madison Sts. to Struck Constr. Co., 147 North Clay St. Estimated cost $400,000.

Md., Baltimore—Western Electric Co., 106 Smith St., plans the construction of boiler house and power unit, also insulated wire plant.

Mich., Benton Harbor—B. M. Nowlen & Co., 156 West Main St., is having plans prepared for a 2 story, 125 x 250 ft. mill work factory on West Main St. Estimated cost $55,000. H. W. Harper, Fidelity Bldg., is architect.

Mich., Detroit—Aircraft Display Case Co., 300 East Jefferson Ave., awarded contract for the construction of a 2 story, 140 x 265 ft. factory on East Jefferson Ave., to M. W. Standish, 300 Fiske Ave. Estimated cost $95,000. Equipment for the manufacture of display cases will be required.

Mich., Detroit—Detroit Show Case Co., 1654 West Fort St., is having plans prepared for the construction of a 2 story, 60 x 130 ft. factory on West Fort St. Estimated cost $40,000. B. C. Wetzel & Co., Dime Bank Bldg., are architects.

Mich., Kalamazoo—Checker Cab Mfg. Corp., Pitcher and Gibsons Sts., awarded contract for the construction of a 1 and 2 story, 320 x 505 body manufacturing plant, 90 x 100 ft. service building, 50 x 100 ft. lacquer building, etc. 50 x 55 ft. power plant to R. Sollitt & Sons Co., South Bend, Inc. Estimated cost $500,000. Equipment will be required.

Mich., Marysville—Gar Wood Inc., Algonac, is having plans prepared for a 1 story, 70 x 350 and 70 x 550 ft. motor boat factory, here. Estimated cost $125,000. Private plans.

Mich., Port Huron — United Brass & Aluminum Co., Goulden Ave., is having plans prepared for the construction of a 1 story, 50 x 300 ft. brass and aluminum factory. Estimated cost $45,000. G. L. Harvey, Federal Commercial Bank, is architect. Equipment for the manufacture of brass and aluminum products.

N. J., Newark—Fougner & Gautier, archts., 103 Park Ave., New York, bids about November 1, for a 4 story, 100 x 140 ft. factory, for Tung Sol Lamp Wks., Inc., 95 8th Ave. Estimated cost $150,000. Noted Sept. 24 .

N. J., Trenton—Nucar Forwarding Co., Prospect St., plans the construction truck and trailer factory. Estimated cost $50,000.

N. J., West New York—De Luxe Auto Bodies, Inc., P. Wiskidensky, pres., 5124 Hudson Blvd. plans the construction of auto body manufacturing plant, Hudson Blvd. and 21st St. Estimated cost $40,000.

N. Y., Buffalo—Stuart Motor Corp., 93 Dewey Ave., awarded contract for the construction of service building, 93 Dewey Ave. to R. E. Williams, Jackson Bldg. Estimated cost $64,533.

O., Warren—Republic Iron & Steel Co., South Market St., Youngstown, received lowest bid for the construction of a 100 x 600 ft. mechanical tube plant from Heller-Murray Co., 222 West Rayen St., Youngstown. Estimated cost $1,000,000.

Pa., College Hill (mail Beaver Falls)—Babcock & Wilcox Tube Co., 85 Liberty St., New York, has work under way on two 1 story, 60 x 560 and 100 x 775 ft. additions to tube mills. Private plans. Work will be done by separate contracts. Structural steel and foundation contracts awarded.

Tenn., Franklin—Allen Mfg. Co., 300 Tenth Ave., Nashville, acquired a site and plans the construction of a foundry and machine shop plant for the manufacture of stoves, here. Estimated cost $200,000.

Wash., Vancouver — Vancouver Cross Arms Co., plans immediate establishment of a 70 x 586 ft. cross arm factory, electrically equipped throughout.

Ont., Dehi—Imperial Tobacco Co., 3820 St. Antoine St., Montreal, Que., awarded contract for the construction of a processing plant and warehouses including 100 x 330 ft. storage building, 100 x 300 ft. boiler house, etc. on Main St. W. to G. H. Emery Construction Co., Dowker Bldg., Windsor. Estimated cost $250,000. Complete tobacco processing equipment will be required.

Ont., Hamilton — Coffield Electric Washing Machine Co., 80 Park St. N., is having plans prepared for the construction of a 1 story factory. Estimated cost $100,000.

Ont., Waterloo—Waterloo Mfg. Co., A. T. Thom, genl. mgr., plans the construction of a factory addition, Union St. Estimated cost $250,000.